THE AVIATION FACTFILE

MILITARY AIRCRAFT OF THE COLD WAR

GENERAL EDITOR:
JIM WINCHESTER

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Contents

INTRODUCTION

Above: One of the first supersonic fighters, the Vought F-8 Crusader pushed back the boundaries of naval aviation in the 1950s and battled with MiGs in Vietnam a decade later.

Left: A major component of the free world's Cold War nuclear forces, Britain's majestic Avro Vulcan ruled the skies for more than two decades.

Right: Ilyushin's Il-28 was the mainstay of the Warsaw Pact tactical bomber force in the early Cold War period.

Far right: When it was introduced in the late 1950s, the Convair F-106 was one of the fastest fighters in the world.

The 'Cold War', a term coined by George Orwell in 1945 but popularized by journalist Walter Lippmann in 1947, lasted 46 years. It began when the allies divided Germany into zones of occupation and ended in 1991 when the USSR split into the Commonwealth of Independent States (CIS). During the Cold War, the USA and NATO, and the USSR and the Warsaw Pact stood braced for armed conflict with each other, with ideological conflicts, mutual fear and mistrust fuelling the development of military aircraft technology and weaponry.

Missile Innovations

This was the age of the missile. Air-to-air, air-to-surface, surface-to-air, and most importantly, surface-to-surface missiles were evolving at a furious rate. Some believed they would replace manned warplanes altogether. In 1957, in Britain, the Defence Secretary cancelled all fighter and bomber projects except the Lightning. In fact, missiles never replaced bombers or fighters, but made them more capable. Missile defences, however, spurred new tactics, such as a switch from high- to low-level attack and the use of specialized anti-radar variants of fighter aircraft like the

F-105G Thunderchief and the F-4G Phantom II.

Spies and Sensors

As World War II receded, the West's knowledge of Soviet military equipment and capabilities grew increasingly outdated. The sheer immensity of the country meant that even nuclear bomb tests could be carried out in complete secrecy to outsiders. Before spy satellites were developed and fielded in the early 1960s, pictures of new bases, new aircraft, and industrial and nuclear sites could come only from flying over Soviet territory, or just outside it and peering over the border with long-range cameras and sensors. Likewise, flights were required to analyze radars, radio traffic and missile telemetry signals in order to ferret out the electronic emissions. Similarly, various aircraft were adapted to sniff out radiological evidence of a suspected bomb test.

This could be dangerous work. Between 1950 and 1970, over 250 Western military personnel were killed in incidents involving surveillance. Many aircraft were shot down on missions around the Soviet periphery. Most dramatic of all was the loss of Francis Gary Powers' Lockheed U-2 spy plane

Above: Britain's best-loved fighter of the post-war period, the English Electric Lightning.

Left: The Myasishchev M-4 'Bison-A' was operated as a bomber by the Soviet air force.

Far left: For 20 years, bomb-laden Harriers stood ready to fight at RAF bases in Germany.

Right: The MiG-17 'Fresco' was one of the most widely exported of all Soviet military aircraft

Far right: F-4 Phantoms of the US Navy.

on May Day 1960. The subsequent capture of Powers revealed the overflight programme, at the time kept secret from the public in both the USA and the USSR. Overflights had been a thorn in the side of the Moscow government, and they ended with Powers' capture.

Cuba Crisis

The discovery in 1962 of preparations to install Russian ballistic missiles in Cuba sparked off the Cuban Missile Crisis, in which the U-2 was again involved. U.S. Air Force RF-101 Voodoos and Navy RF-8 Crusaders also flew dangerous low-level reconnaissance missions to photograph Soviet ballistic missiles and their protective SAM sites. Aerial reconnaissance was vital in detecting the missiles and establishing that they were not yet operational, forestalling a preventative nuclear strike by the USA and averting World War III.

NATO

In the years immediately after World War II, the European members of NATO, excluding Britain and France (which withdrew from the organization in 1966) were largely equipped with aircraft of American design. These were supplied under various so-called Military

Assistance Programs until their national industries recovered from the war. Later, aircraft like the F-104 Starfighter and the F-16 Fighting Falcon manufactured in the USA were not only adopted by European NATO members in large numbers but also assembled in factories across the continent as well.

France and Sweden maintained a capability to design and build their own combat aircraft throughout the Cold War years, as did Britain. The only non-collaborative product to come out of the UK today, however, is the BAE Systems (formerly British Aerospace, formerly Hawker Siddeley) Hawk.

Warsaw Pact

Soviet allies and 'client states' had little choice in their equipment. Less favoured or trusted states received significantly 'sanitized' equipment compared to those issued to Soviet front-line units and those of Warsaw Pact nations, such as East Germany and Poland. Along with Soviet equipment went Soviet military doctrine, which emphasized close ground control of air units rather than individual initiative. When Western-trained pilots met their Soviet-trained counterparts in the skies of the Middle East or Asia, the spoils usually went to the former, except where restrictive

rules of engagement prevented the Western aircraft using their superior weapons to advantage.

Wars By Proxy

Another World War was averted, but the superpowers fought several wars – Korea 1950–53, Vietnam 1964–1975, and Afghanistan 1979–90 – by proxy. These involved all types of aircraft, from light liaison aircraft to strategic bombers and all aerial weapons short of nuclear ones.

These wars by proxy tended to be local conflicts and were usually nationalist in origin. The superpowers became involved for political reasons. Such conflicts also proved convenient testing grounds for the latest weapons and tactics.

Jet Battles over Asia

In Korea, the opposing MiG-15 'Fagot' and F-86 Sabre were as closely matched as any fighters since the Battle of Britain. They fought the last major air battles before the air-to-air missile (AAM) came to dominate air combat, and the superior training and tactics of the American pilots brought about their 12-1 kill ratio over their North Korean, Chinese and Russian adversaries. In Vietnam, the Americans initially fought

Far left: The Republic F-84F introduced a new standard of precision as a fighter-bomber. Its versatility ensured it a long career.

Left: The Convair B-58 Hustler was the world's first supersonic strategic bomber.

Right: The Tornado ADV (Air Defence Variant), designed to defend British airspace.

Below: The Tupolev Tu-16 'Badger' brought the jet age to Moscow's strategic air fleet.

MiGs that were barely better than those they had met over Korea, yet they were having trouble achieving parity despite their radar and guided missiles. The complicated Phantoms and Crusaders, and their AAMs, suffered from poor reliability, and the rules of engagement, requiring positive visual identification, meant that the US jets were drawn into close combat where the more manoeuvrable MiG-17s were at an advantage. Greater American emphasis on air combat manoeuvering (ACM) training redressed the balance by the war's end, but never brought air superiority.

End of an Era

The Cold War ended, in part, because the West outspent the East. Direct conflict between the superpowers was thankfully avoided, and the 'peace dividend' saw massive reductions in military procurement budgets. New combat aircraft types have appeared at a slower rate and production has been much reduced. Many of the aircraft types in this volume continue to serve the world's air forces in the era after the Cold War.

Above: The Saab Viggen was one of the first modern fighters to fly with canard foreplanes.

AÉROSPATIALE (WESTLAND)

SA 330 PUMA

● All-weather transport helicopter ● Gulf and Bosnia veteran

▲ *Despite their advancing years, Pumas are still widely used by the world's armed forces, including those of its original customers, France and the U.K. RAF examples took part in the First Gulf War.*

Building on its experience with the earlier, larger Super Frelon, Sud Aviation (later Aérospatiale) answered the French army's call for an all-weather medium transport helicopter with the Puma. France and later Britain ordered sizeable fleets. Civil operators, too, found uses for what was to be the first all-weather helicopter in the West. Military and civil exports have flourished and the Puma is still in service more than 40 years later.

PHOTO FILE

AÉROSPATIALE (WESTLAND) SA 330 PUMA

◀ Still in active service
France deployed Pumas to the former Yugoslavia for use by the U.N. This example fires self-protection flares.

▼ Civilian sales
A Japanese civil SA 330 with flotation gear fitted to the nose and sponsons. This would inflate if the aircraft ditched.

◀ Say aaah!
A Puma will fit in the hold of a C-5 Galaxy—once its rotors have been removed. This RAF Puma is en route to the Persian Gulf in 1991.

◀ Oilfield support
Once the Puma had been equipped with radar for night/all-weather flying, operators in the oil industry became valued customers. Bristow Helicopters supports rigs in the North Sea.

◀ Early prototype
The SA 330A prototype first flew in 1965. This is the fifth of eight prototypes ordered in June 1963. In 1968 the last of this batch was delivered to the U.K. for evaluation.

FACTS AND FIGURES

- SA 330Js and Ls were the first Western helicopters certified for all-weather flight including operations in icing conditions.
- Aérospatiale replaced the Puma with the more powerful Super Puma from 1981.
- In the 1982 Falklands War Argentina used Pumas to move radars from site to site.
- The RAF's Pumas have given over 35 years' service.
- The Puma prototype had two 970-kW (1,300-hp.) engines; SA 330Ls have two with 1175kW (1,575 hp.) power.
- Romanian Pumas have been armed with 9M14 (AT-3) anti-tank missiles.

PROFILE

First all-weather Western chopper

To fill a French army requirement for an all-weather medium-lift transport helicopter, Sud Aviation (later to become part of Aérospatiale) designed the SA 330.

This, France's first attempt to build a medium helicopter without outside technical contributions, was a resounding success, though the all-weather capability did not come until after several years of development.

The first deliveries of SA 330Bs to the French army took place in 1969, the type becoming operational the following year.

Meanwhile, the last pre-production Puma was being modified by Westland for the RAF. After promising tests, a joint production agreement was reached and the British firm built 48 SA 330Es (Puma HC.Mk 1s).

Aérospatiale went on to build 686 SA 330s (before switching production to the Super Puma in 1981) in successively improved versions for numerous export customers. These included civil operators, especially those in the oilfield support industry once the all-weather capability was available in the SA 330J and L. Between 1970 and 1984, Aérospatiale sold 126 civil models in all.

Romanian company IAR began license production in 1977 and by 1994 had built over 200. Production of the IAR-330L continues at the IAR Ghimbav plant near Brasov.

Left: The French Orchidée battlefield surveillance radar program was shelved in 1990, but was revived during Operation Desert Storm. The system was carried aboard a Puma.

Above: The U.K. Defence Research Agency at RAE Boscombe Down operated this Puma HC.Mk 1 for several years.

SA 330L Puma

Type: Medium transport helicopter.

Powerplant: Two 1175kW (1,575-hp.) Turboméca Turmo IVC turboshafts.

Maximum speed: 294 km/h (182 m.p.h.)

Service ceiling: 6000 m (19,700 ft.)

Range: 572 km (355 mi.) at cruising speed.

Accommodation: Up to 20 fully equipped troops or 3200 kg (7,000 lb.) of cargo.

Weapons: Optional provision for various combinations of weapons including cannons, machine guns, rockets and missiles.

Weights: Empty 3615 kg (7,953 lb.); max takeoff 7400 kg (16,280 lb.)

Dimensions:

Main rotor diameter	15 m (49 ft. 3 in.)
Length	18.15m (59 ft. 6 in.)
Height	5.14 m (16 ft. 10 in.)
Rotor disc area	176.7 m² (1,901 sq. ft.)

SA 330H PUMA

The SA 330H is known to the French air force as the SA 330Ba. 1515 was based in the French Caribbean with Overseas Transport Squadron No. 58 in 1983.

The fully articulated main rotor with four aluminum blades on the initial production SA 330s were replaced by a new rotor with composite blades in the SA 330J and L.

Turboméca's Turmo turboshaft engine was also used in the SA.321 Super Frelon heavy transport helicopter of the early 1960s.

The tail rotor has five blades to absorb the power of the two engines while maintaining low noise levels.

Dual flight controls are standard on the Puma, which flies with two flight deck crew. There are two independent hydraulic systems.

The Puma's tricycle landing gear is semi-retractable and there is provision for pop-out flotation gear.

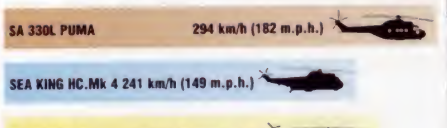
The main cabin of the Puma was designed to hold 18 passengers. In the military transport role 3200 kg (7,000 lb.) can be carried (or 2500 kg/5,500 lb. on an internal hoist). RAF Pumas have a door-mounted rescue hoist with a 575 kg (1,265-lb.) capacity.

Though painted in a predominantly green camouflage color scheme, this Puma also carries large patches of Day-Glo paint work, indicating a search-and-rescue role.

ACTION DATA

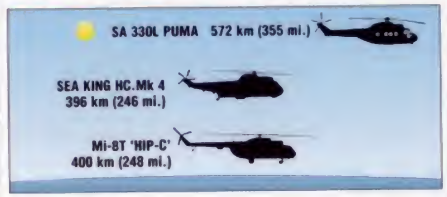
SPEED

Late-production Pumas have a good top speed compared to other helicopters in a similar category. Both the Sea King and Mi-8 are, however, slightly larger aircraft.



RANGE

Though smaller than the Sea King and Mi-8, the Puma has a good range with its maximum load aboard. With over 90 miles more range, Pumas can lift almost as much as larger types.



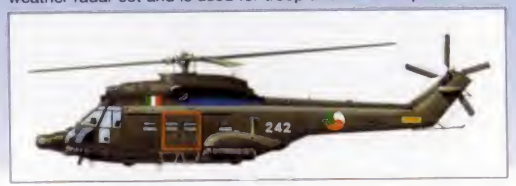
PAYLOAD

Its ability to lift over three tons combined with its relatively compact size makes the Puma ideal for the tactical transport role and also oil rig support sorties.

Military Pumas show their colors

■ **ROYAL AIR FORCE SA 330E (PUMA HC.MK 1):** XW229 was painted in tiger stripes for a NATO Tiger Meet while with No. 230 Squadron based in West Germany in the 1980s.

■ **IRISH AIR CORPS SA 330J:** The single SA 330J used by the Irish Air Corps is a converted civil example. It has the standard weather radar set and is used for troop and VIP transport.



■ **BELGIAN GENDARMERIE SA 330H:** Assigned to NATO in time of war are three civil-registered upgraded export model SA 330Hs, normally used for VIP transport and flown by army pilots.

ANTONOV

AN-2 'COLT'

● Biplane utility aircraft ● Post-war design ● More than 18,000 built

When the first An-2 flew in August 1947, nobody could have predicted that it would become the best-selling post-war aircraft. Yet it has remained in production for more than 40 years and at least 18,000 examples have been built in Russia, Poland and China. The biplane configuration that makes it look so old-fashioned in the jet age gives it outstanding short take-off performance and low-speed handling qualities.

▲ *Entering service in 1948, the An-2 immediately became the standard utility type for Aeroflot and the armed forces. More than 10,000, mainly Polish-built examples, have been delivered.*

PHOTO FILE

ANTONOV AN-2 'COLT'

◀ Sturdy design
Just like the wartime C-47 transport, the An-2 has been an economical, rugged aircraft.

▼ Fedya, the spotter aircraft
The An-2F Fedya had a new rear fuselage for a tactical observer and a 12.7-mm (0.5-in) machine gun in a dorsal cupola.

▼ Soviet colours
Naturally, the Soviet armed forces have been the biggest users of the An-2 in its various versions. Since the break-up of the Soviet Union, Russia operates the largest fleet of 'Colts', with more than 300 examples in the utility role.

▼ 'Scimitar' blades
Early production aircraft were fitted with a 3.6-m (11-ft 10-in) V-509A propeller with four scimitar-like blades. The usual propeller on later aircraft was a 3.35-m (11-ft) example with straight blades.

◀ Atmosphere sampler
An-2ZA had a heated compartment for a scientific observer, faired into the tailfin and accessed from the fuselage. The aircraft's ASh-62IR engine was fitted with a turbocharger to maintain 634 kW (850 hp) at its operating ceiling of 9500 m (31,170 ft).

FACTS AND FIGURES

- Originally, An-2s had a two-man crew: a pilot and flight engineer. The pilot was not allowed to touch the engine controls.
- 'Anusha' (or 'little Anna') is a common nickname for the An-2 in Eastern Europe.
- Some Chinese Y-5s were built with Pratt & Whitney PT6A turboprops.
- During its design, consideration was given to a welded tube and fabric structure to allow local repairs.
- An-2s have been fitted with glider tow hooks; all are easily fitted with skis.
- For parachute training, the cargo door is removed and a static line fitted.

PROFILE

Irreplaceable 'little Anna'

Tasked with designing a replacement for the Po-2 agricultural aircraft, Antonov chose the biplane configuration because it gave the aeroplane manoeuvrability and compactness. The An-2 was soon in production for a host of uses, from airline transport and paratroop training to crop-spraying and ambulance work.

By 1959, around 5450 An-2s had been built in the Soviet Union, when production was transferred to Poland. Since then, WSK-PZL has built more than 12,000 (mostly for the Soviet Union), including several locally developed variants.

Meanwhile, Nanchang had flown the first Chinese-built An-2 in 1957, under the designation Y-5. Shijiazhuang took over Chinese production in 1968, bringing the total aircraft built in the country to around 1000, including the Y-5B modified agricultural model.

Thousands of An-2s remain in service around the world. Fitted with wheels, skis or floats, they are used for water-bombing, aerial survey, glider towing and a host of other military roles, although the majority were completed as agricultural aircraft. A turboprop conversion designated An-3 was flown, but plans to convert large numbers of An-2s were abandoned.

Above: Since 1959, An-2 production has been concentrated at the PZL-Mielec plant in Poland.

Below: Among the many nations to have received versions of the An-2, Egypt chose to finish its aircraft in appropriate desert colours.

Y-5

Manufactured under Soviet licence, the An-2 was built in China for 30 years for both civil and military duties. The first of 948 examples from Nanchang and Shijiazhuang (SAP) factories flew on 7 December 1957.

An-2P 'Colt'

Type: biplane utility aircraft

Powerplant: one 746-kW (1,000-hp) Shvetsov ASh-621R nine-cylinder air-cooled radial engine

Maximum speed: 258 km/h (160 mph) at 1750 m (5,740 ft)

Climb rate: 210 m/min (689 fpm) at sea level

Range: 900 km (560 miles) at 1000 m (3,280 ft) with 500-kg (1,100-lb) payload

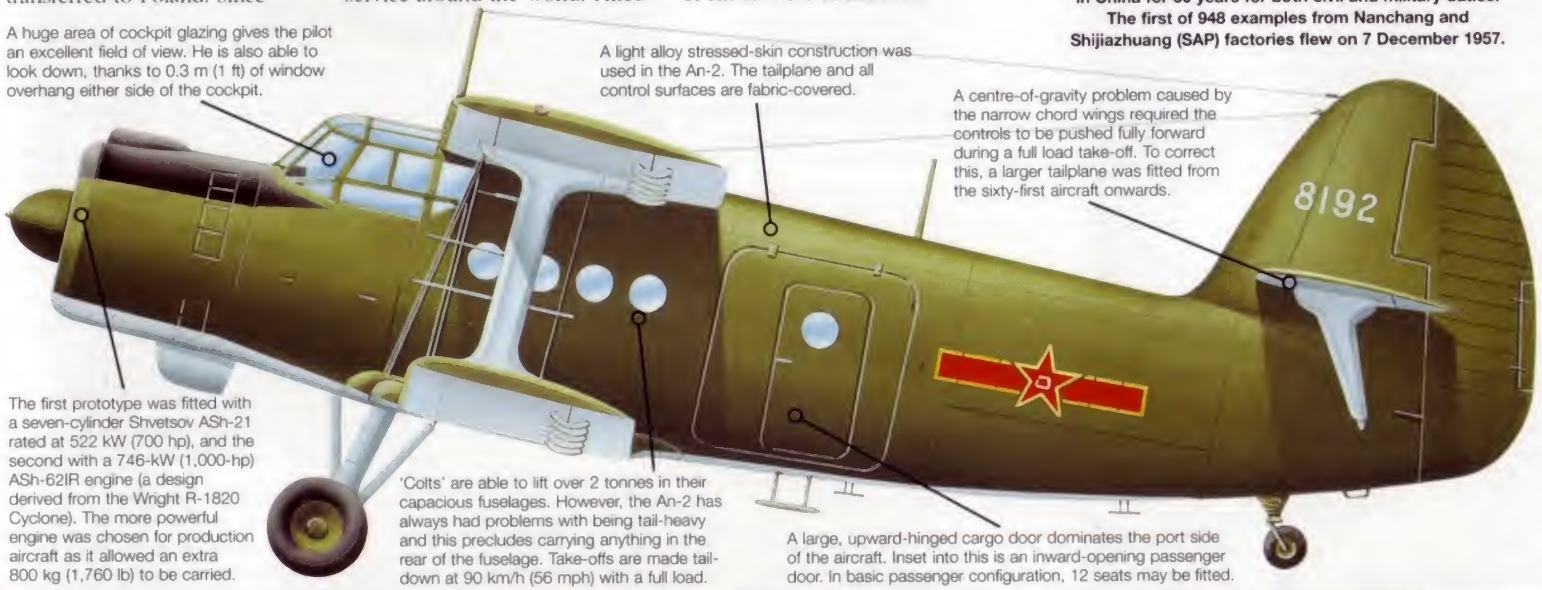
Service ceiling: 4400 m (14,425 ft)

Weights: empty 3450 kg (7,606 lb); maximum take-off 5500 kg (12,125 lb)

Accommodation: two crew plus 12 passengers or 2140 kg (4,700 lb) of cargo

Dimensions:

span	18.18 m (59 ft 8 in)
length	12.74 m (41 ft 9 in)
height	6.10 m (20 ft)
wing area	71.52 m² (770 sq ft)



A huge area of cockpit glazing gives the pilot an excellent field of view. He is also able to look down, thanks to 0.3 m (1 ft) of window overhang either side of the cockpit.

A light alloy stressed-skin construction was used in the An-2. The tailplane and all control surfaces are fabric-covered.

A centre-of-gravity problem caused by the narrow chord wings required the controls to be pushed fully forward during a full load take-off. To correct this, a larger tailplane was fitted from the sixty-first aircraft onwards.

The first prototype was fitted with a seven-cylinder Shvetsov ASh-21 rated at 522 kW (700 hp), and the second with a 746-kW (1,000-hp) ASh-62IR engine (a design derived from the Wright R-1820 Cyclone). The more powerful engine was chosen for production aircraft as it allowed an extra 800 kg (1,760 lb) to be carried.

'Colts' are able to lift over 2 tonnes in their capacious fuselages. However, the An-2 has always had problems with being tail-heavy and this precludes carrying anything in the rear of the fuselage. Take-offs are made tail-down at 90 km/h (56 mph) with a full load.

A large, upward-hinged cargo door dominates the port side of the aircraft. Inset into this is an inward-opening passenger door. In basic passenger configuration, 12 seats may be fitted.

'Colts' in worldwide service

■ **NORTH KOREAN Y-5:** 'Red 44' is finished in the all-over matt black worn by Chinese-built Y-5s involved in night-time covert operations over South Korea.

■ **POLISH An-2V:** Seen in Polish markings, this float-equipped An-2V further illustrates the versatility of the 'Colt'. Floats tended to be fitted at factory or major depot level, rather than in the field.

■ **SOVIET An-2TD:** This parachute training version of the An-2 carries the markings of DOSAAF, the huge paramilitary grouping which organized all sporting aviation in the Soviet Union.

ACTION DATA

ECONOMIC CRUISING SPEED

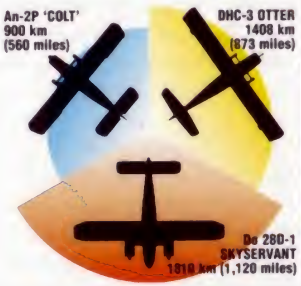
Speed is not a major consideration in the design of any of these utility aircraft. Short take-off and landing (STOL) performance and load-carrying ability are more important parameters, together with economy of operation.

PASSENGERS

The An-2 is a large design for a single-engined aircraft, equipped with a sizeable fuselage for 12 seats in standard passenger configuration, or more than 2000 kg (4,400 lb) of cargo in the freight transport role. A comparable Western design is the de Havilland Canada Otter, although this cannot carry the same payload as the 'Colt'.

RANGE

Where the An-2 has been left behind by some more recent Western designs is in its range performance. The twin-engined Skyservant has a range twice that of the An-2. Recently, DHC-3s have been fitted with the ASh-62 engine to improve performance.



ANTONOV

AN-22 ANTEI 'COCK'

● Strategic airlifter ● Multiple record-breaker ● Turboprop power

Antonov's design bureau, based at Kiev in the Ukraine, is renowned for producing some of the world's biggest aeroplanes. The An-22, with its maximum take-off weight of 250 tonnes (275 tons) including an 80-tonne (88-ton) payload, was certainly the largest of its day. At one stage Antonov was working on designs for even bigger versions, one of which would have carried 724 passengers on two decks, but An-22 production was halted in 1974.

▲ *Designed to move heavy and outsized loads around the vast expanse of the Soviet Union, the An-22 'Cock' has served reliably in the harshest of environments.*

PHOTO FILE

ANTONOV AN-22 ANTEI 'COCK'

Huge transport ▶
Ground personnel lend scale to the An-22. Everything about the aircraft is huge, including its 6.20-m (20-ft 4-in) diameter contra-rotating propellers, which are the world's largest mechanically coupled units.

◀ Gull-winged grace
With its distinctive gull wing the 'Cock' is a graceful shape once airborne. This aircraft has its starboard propellers feathered.

▼ Airline service
This Antei, in common with roughly half of those produced, wears civilian markings. In spite of this Aeroflot identity, all An-22s seem to be tasked with military duties.

◀ Antei air drop
A variety of loads may be air-dropped from the An-22's twin rear doors. The 'Cock' is strictly a freighter.

▼ Take-off
Two An-22s line up to take off. The aircraft's specialist abilities remain as valuable as ever.

▲ Missile loading
Missile systems and main battle tanks are standard military loads for the 'Cock'. Folding doors allow straight-in vehicle loading.

FACTS AND FIGURES

- In 1966 the prototype An-22 set 12 world load and height records; they were bettered by another An-22 in 1967.
- I.J. Davidov took the Antei aloft for the first time on 27 February 1965.
- When production ended in 1974, it is estimated that 66 An-22s had been built.
- A 75,000-tonne (82,673-ton) press was used in the manufacture of the main fuselage frames and principal wing components.
- Undercarriage tyre pressures can be altered in flight to suit runway conditions.
- One An-22 in Russian air force service has been seen in three-tone camouflage.

PROFILE

Gull-winged tank transporter

First flown in February 1965, the An-22 was similar in configuration to the An-12 'Cub', although much bigger and with twin tailfins to improve control and to keep the tail section to a practical height. The pressurized forward fuselage can seat 29 passengers, but the 'Cock' was built to carry freight rather than people.

The An-22's titanium-floored main hold has two travelling cranes and two winches to assist with loading and unloading. With 33 m (108 ft) of usable length and a 4.40-m (14-ft 5-in) square cross-section, the cabin can accommodate main battle tanks and other similar heavy loads. With a 45-tonne (50-ton) payload the Antei is capable of travelling more than 10,000 km (6,200 miles).

Of the estimated 66 An-22s produced, 55 remain in the inventory, but fewer than this are still in service. Most carry Aeroflot markings, although their main role is as military transports.

A few An-22s have been adapted to carry wings for the An-124 – a later Antonov contender for the title of world's biggest aircraft – from Tashkent to the assembly line in Kiev. The advantage of this method over the 'Super Guppy' style of aircraft used by Airbus is that the wing, mounted on pylons above the fuselage, generates additional lift.

Below: This An-22 saved its An-124 successor from embarrassment by flying a spare engine for it to the 1988 Farnborough Air Show.

Above: A classic shot of an An-22 operating from a snow-covered airfield. The aircraft is capable of flying from rough strips.

AN-22 ANTEI 'COCK'

The An-22 was the Soviet's main heavylift aircraft when it entered service. It has since been supplemented by the An-124 and An-225 but remains a vital transport aircraft.

When designing the An-22, Antonov was unwilling to take on the complexities of building a complete pressurized fuselage. As a result, only the forward section of the cabin, with seating for passengers, is pressurized.

Some of the most powerful turboprop engines ever built power the An-22. The basic NK-12 was developed by a mainly German team, headed by an Austrian engineer. Design of the powerplant is credited to Kuznetsov.

Even in profile the pronounced droop of the Antei's outer wings is evident. The main wing box forms a fuel tank with a capacity of 55,800 litres (14,740 US gal), or 43,000 kg (94,800 lb), of fuel. The tank runs from almost one wingtip to the other. Pressure refuelling points are mounted in the undercarriage fairings.

Having produced the basic An-22 design by scaling up the successful An-12, it was decided to fit twin fin and rudder assemblies. This allowed better control in asymmetric flight, when one or both engines on the same side are inoperable.

There are two doors at the rear of the cabin. The lower one opens to ground level for easy loading and also contains tracks which allow the cabin cranes to move out onto the opened ramp.

Large fairings on either side of the lower fuselage contain the 12-wheeled main landing gear. Six wheels are used on each side, mounted in rows of three twin-wheeled bogies. Auxiliary power units and systems controlling cabin air are also contained in the fairings.

An-22M Antei 'Cock'

Type: strategic military transport

Powerplant: four 11,186-kW (15,000-hp) Kuznetsov NK-12MA turboprops

Maximum speed: 740 km/h (460 mph)

Take-off run: 1300 m (4,265 ft) at maximum take-off weight from a concrete surface

Range: 5000 km (3,100 miles) with maximum payload; 10,950 km (6,800 miles) with 45,000-kg (99,208-lb) payload

Service ceiling: 7500 m (24,600 ft)

Weights: empty 114,000 kg (251,327 lb); maximum take-off 250,000 kg (551,156 lb)

Payload: maximum 80,000 kg (176,370 lb)

Dimensions:

span	64.40 m (211 ft 3 in)
length	57.90 m (190 ft)
height	12.53 m (41 ft 1 in)
wing area	345.00 m² (3,714 sq ft)

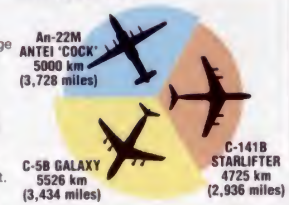
ACTION DATA

PAYLOAD

Although it cannot match the payload capabilities of the Galaxy, the An-22 has proved to be an excellent airlifter with good field performance. It can carry a far greater payload than its second US rival, the Lockheed C-141B StarLifter.

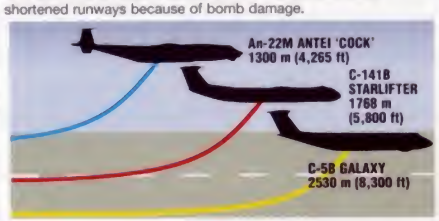
RANGE

These figures show range with maximum payload. Again, the C-5B is the leader, but the An-22 offers better range than the C-141B with almost twice the payload. This ability makes the Antei a highly versatile aircraft.



TAKE-OFF RUN

For operations from short strips while carrying heavy loads, the An-22 excels among these types. Frontline airfields may not be able to offer the services of major air bases and may have shortened runways because of bomb damage.



Airlifters by Antonov

■ **An-12 'CUB':** Roughly equivalent to the Lockheed C-130 Hercules, the An-12 is in widespread service. The An-22 used much of the design philosophy of the An-12.

■ **An-26 'CURL':** An improved version of the An-24, the An-26 was originally intended as a light, tactical transport but has since been developed into a number of specialized variants.

■ **An-74 'COALER-B':** Developed from the An-72 turbofan-powered short take-off and landing airlifter, the An-74 is optimized for Arctic and Antarctic operations.

ANTONOV

AN-24 'COKE'/AN-26 'CURL'

● Twin-turboprops ● Personnel transport ● Tactical airlifters

▲ *Antonov's twins serve in some numbers with both military and paramilitary operators. The majority of An-24s are passenger transports without rear loading ramp doors.*

Designed to satisfy an Aeroflot requirement for a turboprop transport, the An-24 'Coke' also sold in some numbers to military operators as both a passenger and freight carrier. It led directly to development of the An-26 'Curl', a dedicated military tactical transport, which has proven itself to be a rugged and capable performer. In China, unlicensed production of both aircraft has been carried out under the designation Xian Y-7.

PHOTO FILE

ANTONOV AN-24 'COKE'/AN-26 'CURL'

Czech 'Curl' ▶
This aircraft demonstrates the distinctive bubble observation window of the type.

▼ Paradropping
With its large rear door and blister observation window, the An-26 is optimised for the parachute deployment of troops.

▲ Jet APU
The jet exhaust of the APU is clearly seen within the polished section of the starboard engine nacelle of this Czech An-26.

Abraded underside ▼
During rough-field operations debris is thrown up at the underside of the fuselage, as shown by this weathered aircraft.

▼ African 'Coke'
At least five An-24s were supplied to Sudan, but all seem to have been withdrawn from use.

FACTS AND FIGURES

- Very few operators use the An-24 in a freight role; most use the aircraft as a 50-seat passenger transport.
- Under the designation An-24P, one 'Coke' was modified for fire-bombing.
- Antonov claims a corrosion life of 30,000 hours for the An-24 fuselage.
- The An-26 was the first Soviet-designed transport aircraft to have a fully pressurised hold.
- During 1996, Russia had 20 Elint-dedicated An-26s on strength.
- Angola's and Mozambique's air forces have used An-26s as attack aircraft.

PROFILE

Antonov's lightweight airlifters

Having first flown on 20 December 1959, the An-24 'Coke' was a direct competitor to the F27 Friendship. Both aircraft were fundamentally airliners, but both sought military customers, in which quest the 'Coke' came off best. Antonov designed the An-24 with the emphasis on strength and reliability, rather than on lightweight and economical operations.

Early aircraft featured a gas turbine auxiliary power unit (APU) in the rear of the starboard engine nacelle, but this was replaced in the An-24RV by a small turbojet which improved take-off performance. This installation was also a feature of the An-24RT dedicated freighter.

Designed as a tactical airlifter, the An-26 has enjoyed far greater success. It has greater power, an upswept rear fuselage which incorporates a large cargo door, and is fully equipped for the rapid loading and off-loading of freight, light vehicles or paratroops.

Left: Early in 1996, the Libyan Arab Republic Air Force had eight An-26s on strength as transports.

Unusually, the An-26 has a second skin of titanium beneath the fuselage, to protect it during rough field operations. The aircraft has also been developed into a number of special versions, especially for the electronic intelligence, signals intelligence and electronic warfare (Elint, Sigint and EW) roles. All machines in this category are given the NATO designation 'Curl-B'.

Above: Hungary flies the An-24V in the conventional passenger role, alongside An-26 tactical airlifters, as illustrated.

An-26B 'Curl-A'

Type: twin-turboprop tactical transport

Powerplant: two 2103-kW (2,820-hp.) ZMDB Progress AI-24VT turboprops and one 7.85-kN (1,765-lb.-thrust) Soyuz RU-19A-300 turbojet

Maximum speed: 540 km/h (335 m.p.h.) at 5000 m (16,000 ft.)

Maximum climb rate: 480 m/min (1,575 f.p.m.)

Range: 2550 km (1,580 mi.) with maximum fuel or 1100 km (680 mi.) with maximum payload

Service ceiling: 7500 m (24,600 ft.)

Weights: empty 15,400 kg (33,880 lb.), maximum take-off 24,400 kg (53,680 lb.)

Accommodation: 40 passengers on tip-up seats or 5500 kg (12,100 lb.) of cargo

Dimensions:

span	29.20 m (95 ft. 9 in.)
length	23.80 m (78 ft 1 in.)
height	8.58 m (28 ft. 2 in.)
wing area	74.98 m² (807 sq. ft.)

In addition to its five An-24RVs, in March 1996 the Czech air force also had in service four An-26s and a single, Elint-dedicated An-26Z-1M 'Curl-B'.

A flight crew of three is required to operate the An-24. The aircraft represents a departure from previous Soviet design philosophy by having a radar nose instead of the extensively glazed navigator's position normally associated with Soviet transports.

Mounted high on the wing, the powerful turboprops and their propellers are kept away from flying debris. An-24RT and RV machines have an auxiliary turbojet replacing the APU in the starboard nacelle. This provides all electrical power on take-off, allowing the main engines to deliver more thrust to the propellers, as well as providing residual thrust.

AN-24RV 'COKE'

When it was formed in 1992, the Czech air force received a number of An-24s from the former Czechoslovak air force. The aircraft are generally used as staff transports.

In cross-section, the fuselage of both the An-24 and An-26 takes the form of a rounded triangle. This allows maximum floor width, while retaining a nearly circular cross-section which is structurally desirable for a pressurised cabin.

Most military An-24s are flown as pure passenger transports and are designated An-24V, or RV with turbojet APU. A cargo variant was produced as the An-24T (An-24RT) with rear loading and twin ventral fins, but it found few customers.

As a passenger transport, the An-24 was supplied with a small entry door in the port rear fuselage. The ventral fins fitted to An-24Ts were sometimes applied to An-24Vs, as on this example.

ACTION DATA

MAXIMUM PAYLOAD

Although it has a lighter maximum payload than these contemporary designs, the An-26 has a carefully designed hold which helps prevent it becoming space-limited. Many transports are full before they reach their maximum payload weight.

CRUISING SPEED

When normal operational cruising speeds at altitude are compared, Fokker's F27 Mk 4000 Troopship is by far the fastest. It is not as rugged as the other types, however, and has gained a limited market. All three types have their origins in commercial designs.

RANGE

Range with maximum payload is a useful guide to the potential operating ranges of transport aircraft. A maximum payload is rarely carried, but, under most circumstances, the An-26B is likely to offer far superior performance.

'Curl' colours

■ **AFGHANISTAN:** In 1978 the first of about 20 An-26s and a number of An-24s was delivered to the Afghan air force. Some were destroyed by rocket fire, but the survivors remain airworthy.

■ **MALI:** An-26s were first received in 1983 and continue to fly alongside a number of An-24s. 'Cokes' and 'Curls' have proved popular among African nations.

■ **YUGOSLAVIA:** After the divisions within Yugoslavia, the An-26 fleet now flies with Serbian forces. Having stood at 15 in the mid-1980s, numbers totalled 25 by 1996.

ANTONOV

AN-12 'CUB'

● Tactical airlifter ● Flying command post ● Electronic warfare

Antonov's An-12 'Cub' is a big, tough, practical transport often called the 'Soviet C-130' because it closely resembles the West's Lockheed Hercules. The Ukrainian-designed An-12 is a high-wing, four-engined, rear-loading freighter that won wide acceptance in the Soviet military, served the airlines and was copied in China. This versatile machine also operated in Afghanistan and worked as an electronic warfare jammer and testbed.

▲ *Like the C-130, the An-12 was the first transport properly designed for the forces that used it, featuring a high wing, turboprops, rough-field capability, large rear-loading doors and a wide fuselage. The utility of such machines has ensured that the An-12 is still in service today.*

PHOTO FILE

ANTONOV AN-12 'CUB'

▲ Driver's seat
The An-12 cockpit is a spartan place to work, but it is well laid out and offers the pilot a good view for landing.

▲ Soft landing
With its long flaps and low-pressure tyres, the An-12 can easily touch down safely on rough strips at high weights.

Himalaya flyer ▶
India's An-12s operate in the Himalayan range, but the lack of pressurization in the hold often limits their operations there.

▲ Still going strong
The An-12 still remained in service in the mid-1990s: this Aeroflot machine is flying from Zhukovskii.

Aeroflot visitor ▶
Intercepted by an A-7 from the carrier USS Midway, this An-12 was on a reconnaissance mission.

FACTS AND FIGURES

- Many An-12s have been converted for duty as test and research platforms, including engine testbed work.
- When production ended in 1973, about 900 An-12s had been built in the USSR.
- The prototype Antonov An-12 made its maiden flight in 1958.
- China produces the An-12, known as the Y-8, in Xian and has exported the type to Sri Lanka and Sudan.
- Afghan rebels succeeded in downing an An-12 with Stinger missiles.
- Four tonnes (4.4 tons) of electronic warfare gear is carried by the 'Cub-C' jammer.

PROFILE

Supreme Soviet tactical airlifter

Antonov's An-12 'Cub' is the hard-working transport which pilots say cannot be replaced. Although this burly turboprop heavyweight has been out of production for a quarter of a century (its American equivalent, the C-130, is still being built), pilots agree that plans to replace the 'Cub' with jet transports were premature.

The 'Cub' is an enduring presence in the former Soviet Union and is still relied upon to transport military supplies, while also being used for secondary missions. In addition, Aeroflot continues to operate a small number of An-12 civil freighters.

The An-12 is not fully pressurized like the C-130 and it uses a different method of rear loading, which sometimes requires additional ground equipment. Additionally, the An-12 cannot land on a rough, unpaved surface near the battlefield in the short distance of 1500 m (4,920 ft) that is required by the C-130. But when support equipment is available and airfields are used, the An-12 is a champion freight-hauler for a plane of its class.

Aeroflot found the An-12 essential, as a large area of the Soviet Union was totally inaccessible to more conventional aircraft.

The Czech Republic and Slovakia both retained an An-12 each after the division of Czechoslovakia. Although the Slovak An-12 ('2209') is used, the Czechs have retired their aircraft despite having no replacement.

An-12 'Cub'

Type: passenger/cargo transport

Powerplant: four 2983-kW (3,940-hp) Ivchenko AI-20K turboprop engines

Maximum speed: 670 km/h (416 mph)

Cruising speed: 550 km/h (243 mph) at 7620 m (25,000 ft)

Range: 5700 km (3,542 miles)

Service ceiling: 10,200 m (33,500 ft)

Weights: normal take-off 54,000 kg (119,050 lb); maximum take-off 61,000 kg (134,482 lb)

Armament: (on some military An-12s) two 'NR-23' 23-mm cannons in a rear turret

Dimensions:

span	38.00 m (124 ft 8 in)
length	33.10 m (108 ft 7 in)
height	10.53 m (34 ft 7 in)
wing area	121.70 m² (1,310 sq ft)

Like most modern tactical transports, the An-12 was powered by four turboprops, namely the Ivchenko AI-20. Hot air from the engines was used to de-ice the wing and tail.

The wing design for the An-12 was derived from that of the An-10, but held more fuel in its 26 tanks. A high wing design was chosen to allow vehicles to drive around the aircraft easily and for the pilot to see the ground. It also kept the propellers clear of debris on rough airstrips.

A crew of five was accommodated in the front of the An-12 in a pressurized cockpit. The crew consisted of two pilots, a navigator, flight engineer and radio operator.

Some aircraft had an additional pressurized 12-man compartment fitted behind the flight deck to accommodate cargo handlers and vehicle crews.

The fuselage can accommodate vehicles such as the ZSU-23-4 tracked anti-aircraft gun or PT-76 light tank.

The tail turret is based on that of the Tu-16 'Badger' medium bomber and contains two 23-mm cannon. It has a tail warning radar, but not a gun-laying radar. The turret is pressurized for the gunner. Remaining aircraft often have the guns deleted.

Most An-12s had clamshell-style doors, but a few had a C-130-style rear-loading ramp door.

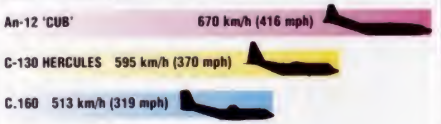
Y-8

The Shaanxi Y-8 is a Chinese-built version of the An-12. Amazingly, this aircraft is still in production and the latest version, the Y-8C, was first flown in 1990 and is widely used by Chinese operators.

ACTION DATA

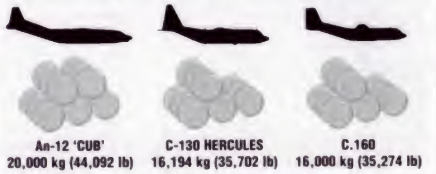
MAXIMUM CRUISING SPEED

With turboprop engines and a bulky fuselage, tactical transports are not designed for speed. The more streamlined fuselage of the An-12 gives it a slightly higher speed than the C-130, but in practice most transports rarely reach their maximum speed.



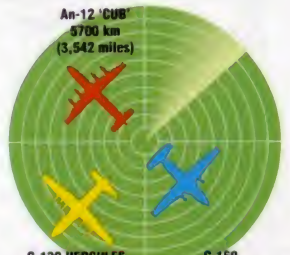
LOAD

The Antonov has impressive load-carrying capability, and can haul more than a C-130. Perhaps the only weakness of the An-12 is that loading the aircraft is slower than a C-130 or a Transall C.160 due to the absence of a rear-loading ramp. The Transall is only a twin-engined design but still manages to carry a fair payload.



RANGE

The An-12 may have less range than a C-130, but it still possesses an adequate radius of action for a tactical transport, especially considering that operations in Europe do not require long stretches without refuelling. Jamming An-12s could stay on station for long stretches at a time.



An-12 missions

BOMBING RAID: India converted several of its An-12BPs to serve as makeshift bombers; 16000 kg (35,270 lb) of palletized bombs were pushed out of the rear doors.

TARGET TANK: The object of the An-12 mission was to attack Pakistani troops and armour during the 1971 conflict.

EJECTION TEST: The An-12 has also been fitted with a special tail cone used for firing ejection seats to test their effectiveness.

ELECTRONIC JAMMER: An electronic warfare variant known to NATO as 'Cub-C' has active jamming gear for blocking communications and radar, and can also dispense 'chaff' barriers to give false returns on radar.

AVRO

SHACKLETON AEW

● Long serving ● UK's sole AEW asset for 20 years ● Piston engined

▲ *Thorough maintenance of the highest quality kept the Shackletons in service for 20 years longer than had been expected, with the highest levels of serviceability at all times.*

The first Boeing E-3D Sentry AEW.Mk 1 arrived at RAF Waddington on 26 March 1991. The Shackleton AEW.Mk 2s of No. 8 Squadron, along with their antiquated radar system which used 1940s technology, could finally be retired. The United Kingdom had maintained a limited Airborne Early Warning (AEW) screen with the Shackleton since 1971, thanks to the skill and ingenuity of the crews. Its intended Nimrod AEW replacement of the mid-1980s was cancelled.

PHOTO FILE

AVRO SHACKLETON AEW

◀ Famous ancestor
This view clearly shows the similarity between the Lancaster and the Shackleton. The latter, however, was a larger machine.

▼ 'Ermintrude' in action
No. 8 Squadron named all of its aircraft after characters in the children's television series The Magic Roundabout.

◀ Lumps and bumps
This near-silhouette shows the plethora of antennas and the large 'guppy' radome beneath the forward fuselage that are associated with the AEW systems.

Griffon power ▶
Six-bladed, contra-rotating propellers were a distinctive feature of the Shackleton.

◀ AEW original
The first Shackleton AEW.Mk 2 made its maiden flight on 30 September 1971. The conversions were based on the MR.Mk 2, as the newer MR.Mk 3s were at the end of their fatigue lives.

FACTS AND FIGURES

- The first MR.Mk 2 entered service in late 1952; the last MR.Mk 2, as an AEW.Mk 2, retired 39 years later.
- In April 1990 a Shackleton was lost when it flew into a hill in the Outer Hebrides.
- All AEW Shackletons retained a search and rescue capability.
- The majority of No. 8 Squadron's initial aircrew complement was made up of ex-Fleet Air Arm Gannet personnel.
- The RAF had planned to retire its Shackletons from 1980 onwards.
- Budget cuts early in the programme reduced the operational force to six.

PROFILE

Avro's last operational design

When the Shackleton AEW.Mk 2 was finally retired from RAF service, several Spitfires benefited from engine and other components donated by the venerable Avro aircraft, such was their age.

Even the most ardent Shackleton supporter admits that by the early 1980s the aircraft of No. 8 Squadron belonged to another era. It was a testimony to the quality of the original design and to the skill of its crews that the Shackleton remained viable as long as it did. It was the RAF's last front-line piston-engined aircraft.

In 1971 the Royal Navy was preparing to lose its aircraft-carriers and fixed-wing air power. This meant there would be no AEW coverage available to Royal Navy ships, as the shipborne Fairey Gannet AEW.Mk 3 would no longer be in service.

In order to provide naval forces and the UK's air defence system with the cheapest possible AEW cover, the Gannets' APS-20 radars were removed and rebuilt to improved APS-20F(1) standard, then fitted to 12 Shackleton MR.Mk 2 airframes. The resulting aircraft served throughout the blighted Nimrod AEW.Mk 3 programme and continued to operate until 1991.

Left: This AEW.Mk 2, WL745, originally appeared wearing the letter 'O', which was applied when it was a MR.Mk 2 serving with No. 204 Squadron.

Below: As the Nimrod AEW aircraft proved impractical, the situation for the antique Shackleton became increasingly desperate.

Shackleton AEW.Mk 2

Type: airborne early warning aircraft

Powerplant: four 1831-kW (2,455-hp) Rolls-Royce Griffon 57A V-12 piston engines

Maximum speed: 439 km/h (273 mph)

Endurance: maximum 15 hours

Initial climb rate: 259 m/min (850 fpm)

Range: 4908 km (3,050 miles)

Service ceiling: 7010 m (23,000 ft)

Weights: empty 25,855 kg (57,000 lb); maximum take-off 44,452 kg (98,000 lb)

Accommodation: typical crew of 10 consisting of four on the flight deck and six mission specialists

Dimensions:

span	36.58 m (120 ft 2 in)
length	26.62 m (87 ft 4 in)
height	5.10 m (16 ft 9 in)
wing area	132.00 m² (1,421 sq ft)

SHACKLETON AEW.MK 2

'Dougal' flew with the RAF's only Shackleton AEW.Mk 2 squadron, No. 8. The aircraft were briefly based at Kinloss, but spent most of their careers flying from RAF Lossiemouth.

In the MR.Mk 2 this position was occupied by the forward gunner, but in the unarmed AEW.Mk 2 it was used as a navigation position and an additional look-out point. It was, apparently, a spectacular position from which to experience an AEW.Mk 2 air show performance.

While the casual observer might have been forgiven for thinking that the AEW.Mk 2 had a funnel, this unusual antenna actually served the APX-7 Identification Friend or Foe (IFF) system.

Avro designer Roy Chadwick was responsible for the entire line of bombers which led to the Shackleton. All used a similar and distinctive tail layout.

A huge ventral radome covered the APS-20 radar. Like the electronics, the radome was also taken from the Royal Navy's Gannets and fitted to the Shackleton.

With regular overhauls the powerful Rolls-Royce Griffon engines were able to power the Shackleton fleet with admirable reliability.

When the AEW.Mk 2s first entered service they retained the white upper fuselage of the maritime variants. This was soon replaced by an overall grey scheme, brightened by No. 8's colourful markings and the obligatory character painted on the forward fuselage.

AEW crews used the glazed tail position as a further observation point. Although the radome covered part of the bomb-bay, the remainder of the bay was used to stow a selection of search and rescue (SAR) equipment, including life rafts for the secondary SAR role.

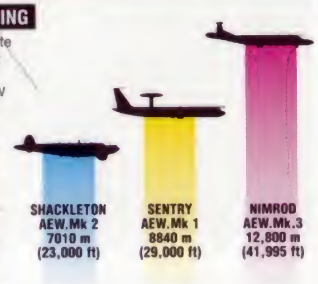
ACTION DATA

MAXIMUM SPEED

Although long patrols are carried out at the most economical speed, a rapid transit to station is highly desirable. This helps to avoid gaps in AEW coverage as a result of unserviceability or other problems.

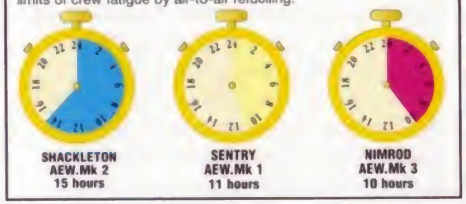
SERVICE CEILING

An ability to operate for long periods at high altitude is useful for any AEW platform as radar range increases with altitude. The service ceiling of the Shackleton is well below the operational ceiling of the Sentry, while the Nimrod outperforms both.



ENDURANCE

The endurance of the Shackleton is truly exceptional. The endurance of the Sentry AEW.Mk 1 is, however, accomplished at 1600 km (1,000 miles) from base and can be extended to the limits of crew fatigue by air-to-air refuelling.



Shackleton family line

■ **LANCASTER:** Developed from the disappointing, twin-engined Manchester, the Lancaster became a classic bomber design. This machine was one of the last flying, and served with the Aéronavale as a B.I(FE) maritime reconnaissance aircraft.

■ **LINCOLN:** Originally known as the Lancaster Mk IV and V, the Lincoln was based on the Lancaster layout but was a much larger aircraft, with more powerful engines. It began being replaced by the Canberra from 1951.

■ **SHACKLETON MR:** This Shackleton MR.Mk 3 is typical of the last Shackletons built. All aircraft in the series were developed from the Lincoln. The use of auxiliary Viper turbojets caused the MR.Mk 3s to reach the end of their fatigue lives prematurely.

AVRO

VULCAN

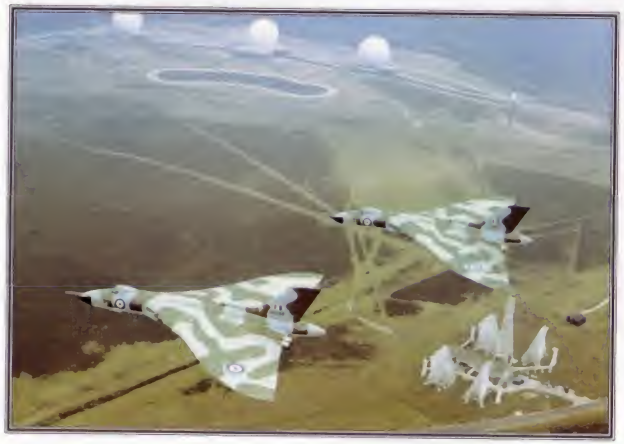
● Strategic missile carrier ● Delta-wing bomber

A major component of the free world's Cold War nuclear forces, the majestic Vulcan ruled the skies for more than two decades. This enormous delta-winged jet was one of the most graceful and beautiful flying machines ever committed to the grim reality of nuclear deterrence. The Vulcan also excelled, however, as a conventional bomber, tanker and reconnaissance platform.

▲ *First flown in 1955, the Avro Vulcan was to spearhead British nuclear and conventional bombing capability for more than a quarter of a century.*

PHOTO FILE

AVRO VULCAN



▲ 'Iron' bomber
Although designed for high-level nuclear strike, the Vulcan was a capable conventional bomber. The maximum bombload of '500-pounders' was over nine tons.

▲ Switch to low level
Development of Soviet air defences meant that in the 1960s the Vulcan's attack profile was changed to low-level penetration, and the men crewing the big bomber had to learn new skills.

▲ Stand-off strike
The Blue Steel nuclear missile meant that the Vulcan could attack key strategic targets up to 350 km (210 miles) away.

◀ Target Falklands
Armourers load 454-kg (1,000-lb) bombs into the belly of a 'Black Buck' Vulcan from the British base on Ascension Island.

◀ Conventional bomber
With weapons bay doors open, an Avro Vulcan banks away at the end of a bomb run.

FACTS AND FIGURES

- Early Vulcans were painted a stunning pure white to reflect nuclear 'flash'.
- The four Olympus engines produced as much power as 18 railway locomotives.
- Vulcan pilots had ejection seats, but in an emergency the other three crewmen had to bail out through hatches.
- The Vulcan's pilot sat 5 m (16 ft) up and used a periscope to steer on the ground.
- The Vulcan could outmanoeuvre F-15s in high-altitude mock dogfights.
- Vulcans flew 12,650 km (7,860 miles) to bomb the Falklands, the longest straight-line combat missions in history at the time.

PROFILE

Vulcan to the fore

The Avro 698 Vulcan was the world's first large aircraft with a delta, or triangular-shaped, wing, and it opened up new frontiers in aerodynamic design. When the Vulcan joined Britain's bomber force, it marked a giant leap forward in technology. In addition to its impressive performance, the Vulcan gave the world a new look: it was one of the most exquisite and best-loved aircraft ever to take to the skies.

The prospect of atomic war was a far from pleasing one, however, and the Vulcan's grisly assignment was to prepare for the worst and to retaliate if a nuclear attack came. This serious business was at first carried out with heavy and awkward atomic and hydrogen bombs, and later with a far-reaching, nuclear-tipped missile called the Blue Steel.

As a conventional bomber, the five-man Vulcan achieved dramatic success in the 1982 Falklands War. Vulcans also served as strategic radar reconnaissance aircraft before their retirement from service in the late 1980s.

The Vulcan's unique delta wing made it highly manoeuvrable for such a large machine.

The prototype Vulcans had straight-wing leading edges. Production wings were kinked, a feature which helped to eliminate buffeting in high-*g* manoeuvring at altitude.

The huge delta wing was the Vulcan's most outstanding feature, which made the aircraft highly agile at height.

The Vulcan had no conventional tail, so all control surfaces were on the wing. Roll control was provided by highly effective ailerons mounted outboard.

The fairing on the tip of the fin housed a passive counter-measures antenna, but most of the defensive electronics were in the tailcone. This also housed a rear-warning radar and twin braking parachutes.

VULCAN B.MK 2

Vulcans were in the process of being retired when they were called into action during the Falklands War. They were used to bomb Port Stanley airfield in the longest raids that had ever been flown up to that time.

The Vulcan flew with a crew of five. The pilot and co-pilot sat on ejection seats beneath the canopy, with navigator, air electronics officer and radar operator facing to the rear behind and below the flight deck.

Upward and downward control of pitch was provided by four large elevators mounted inboard, between the ailerons and the exhausts of the Olympus turbojets.

The inflight-refuelling probe enabled the Vulcan to fly long-range bombing missions against targets more than 6500 km (4,040 miles) away during the Falklands War.

The Vulcan's bombing radar was descended from the World War II H2S set. The 2-m (6½-ft) rotating antenna was housed in the underside of the nose.

Vulcans carried a total conventional bombload of around 9500 kg (20,950 lb), usually composed of three groups of seven 454-kg (1,000-lb) general-purpose high-explosive bombs.

The Vulcan was powered by four Rolls-Royce Olympus turbojets, each delivering 88.97 kN (20,011 lb thrust). The engines were embedded in the wings.

Vulcan B.Mk 2

Type: five-seat long-range bomber

Powerplant: four 88.97-kN (20,011-lb-thrust) Bristol (Rolls-Royce) Olympus turbojet engines

Maximum speed: 1038 km/h (645 mph) at 6096 m (20,000 ft)

Range: 5550 km (3,450 miles) on low-level mission with full bombload

Weight: maximum take-off 90,720 kg (200,000 lb)

Armament: Blue Danube hydrogen bomb, Blue Steel nuclear cruise missile or 21,454 kg (47,300 lb) of conventional bombs

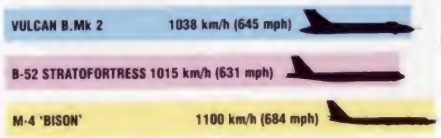
Dimensions:

span	33.83 m (111 ft)
length	30.50 m (100 ft 1 in)
height	8.29 m (27 ft 2 in)
wing area	368.30 m² (3,964 sq ft)

COMBAT DATA

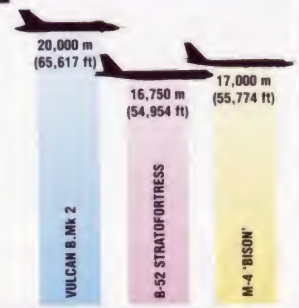
MAXIMUM SPEED

The first generation of strategic jet bombers were as fast as the fighters of the period, and were very hard to catch, particularly when flying high-level missions.

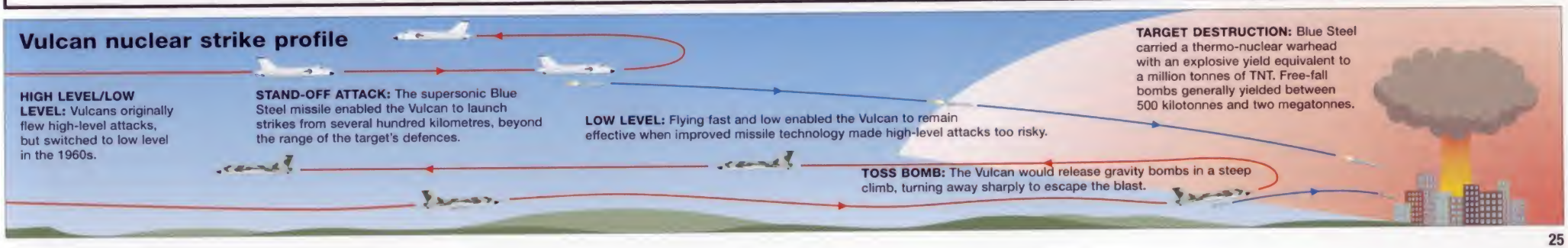


SERVICE CEILING

Bombers tend to have big wings, which enables them to operate at high altitude more effectively than fighters. The Vulcan's huge wing gave it a particular advantage. Even at the end of its career, a well-flown Vulcan at 12,000 m (39,370 ft) could prove a handful even for an F-15 Eagle during mock dogfights.



Vulcan nuclear strike profile



AVRO CANADA

CF-100 CANUCK

● All-weather fighter ● Operational trainer ● ECM platform

When a pilot strapped into the CF-100 Canuck, he knew he was flying an excellent, all-weather warplane that was also Canada's first jet fighter. Avro Canada manufactured this two-man, twin-engined machine for the express purpose of defending North America from bomber attack. Designed in the late 1940s, this ship was one of the most popular aircraft ever to equip a squadron. The Canuck survived in squadron service until the early 1980s, by which time it had been relegated to second-line duties, including ECM missions.

▲ *The CF-100 defended the North American continent from attack. After the cancellation of its intended successor, the CF-105 Arrow, the Canuck remained in service with the Canadian air force in various roles for nearly 30 years.*

PHOTO FILE

AVRO CANADA CF-100 CANUCK

▲ All-weather radar
Early CF-100s carried the Westinghouse APG-33 radar in the nose and eight machine guns in a ventral pack. Later versions carried an APG-40 radar.

High-performance jet ▶
The straight-wing layout of the CF-100 provided a very stable platform. Thanks to its powerful Orenda turbojets, it was also fast enough to exceed the sound barrier in a shallow dive; the first Canadian designed fighter to do so.

Air-to-air rockets ▶
The CF-100 Mk 4 introduced rocket armament, comprising 29 unguided 70-mm (2.75-in) rockets in each wingtip, plus 48 rockets in the ventral tray.

▲ Defence initiative
The Royal Canadian Air Force and the Avro Canada CF-100 Canuck participated in the joint defence of the North American continent with the US Air Defence Command, under the NORAD scheme.

▲ Missile armament
The Mk 3 was modified for testing the Velvet Glove missile. This weapon combination never became operational.

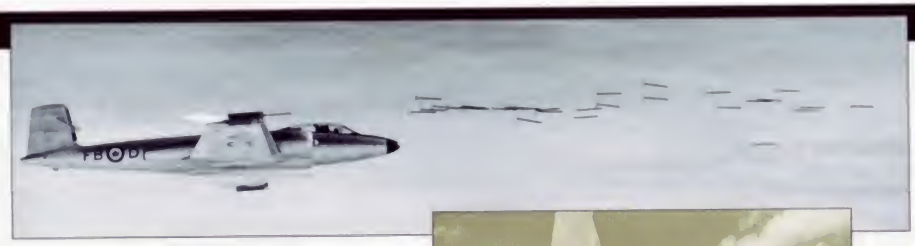
◀ Jet-assisted take-off
The CF-100 had provision for JATO bottles under the rear fuselage, although these were rarely used in squadron service.

FACTS AND FIGURES

- Four CF-100 squadrons were based in Europe, providing NATO allies with valuable all-weather defence.
- Some 692 Canucks were built for Canada and 53 were exported to Belgium.
- Painted all black, the CF-100 prototype made its maiden flight in January 1950.
- Belgium's sole CF-100 squadron was stationed at Beauvechain and was also committed to NATO defence.
- In 1952 a CF-100 became the first straight-wing fighter to exceed Mach 1.
- In the back seat was a radar operator using the APG-40 fire-control system.

PROFILE

Canada's first supersonic jet



Avro Canada began to design its first jet in 1946 and flew the CF-100 in 1950. This long-range interceptor became the backbone of Canada's contribution to the defence of North America and Western Europe.

Although it lacked the swept wings that became standard on most combat aircraft, the CF-100 was a fine all-weather fighter, its stability making it an excellent weapon platform and easy to fly on instruments. Pilots also found the Canuck (a slang term for a Canadian) an easy aircraft to handle at lower speeds when landing or manoeuvring in the airfield pattern. While it was not a dogfighter, for a 90-degree attack on a bomber formation using air-to-air rocket projectiles the CF-100 proved potent.

The Canuck flew alongside American interceptors such as the Northrop F-89 Scorpion and Lockheed F-94 Starfire, but these were never to earn the affection that Canadians bestowed on their airplane.

The definitive model of the CF-100 was the Mk 5, which introduced uprated powerplants and enhanced aerodynamics. The only export customer for the Canuck was Belgium, which received 53 Mk 5s. All served with the 1st All-Weather Interceptor Wing based at Beauvechain. A number of Canadian CF-100s were also based in Europe, some being used for electronic warfare.

Above: Unguided air-to-air rockets were first introduced on the CF-100 Mk 4 and proved to be a great improvement over the machine-gun armament of the Mk 3. A total of 116 rockets could be carried.

Above: The twin Canadian-built Orenda turbojets were non-afterburning, but provided a useful amount of thrust, as well as fuel efficiency and reliability for long-range patrol missions.

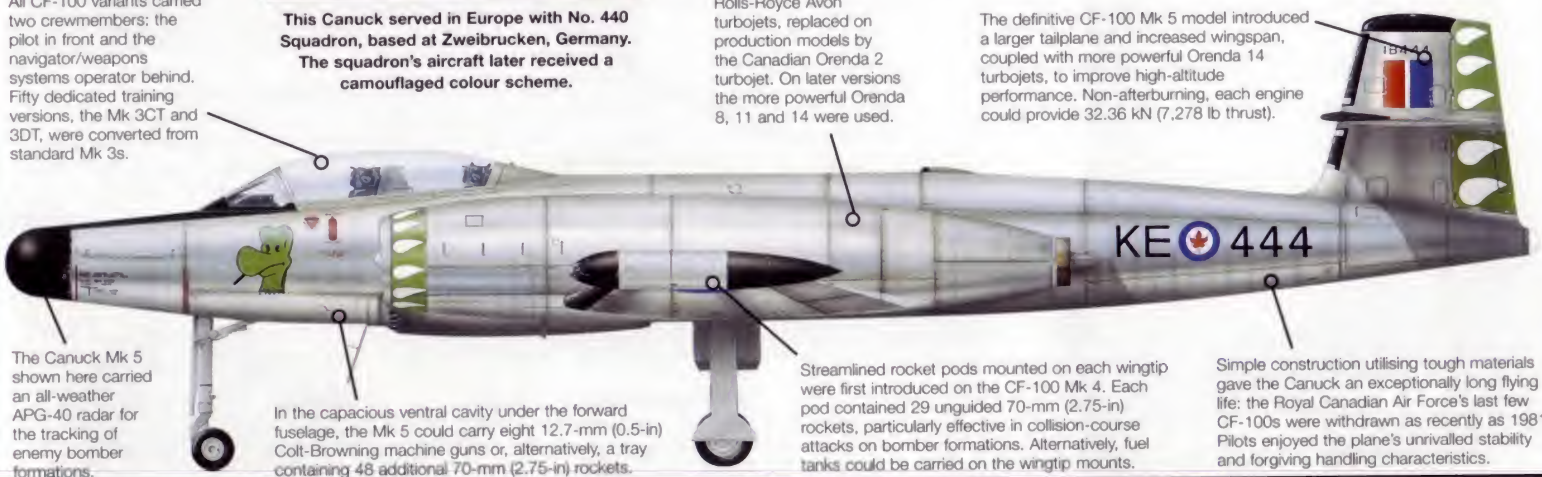
CF-100 CANUCK MK 5

This Canuck served in Europe with No. 440 Squadron, based at Zweibrucken, Germany. The squadron's aircraft later received a camouflaged colour scheme.

All CF-100 variants carried two crewmembers: the pilot in front and the navigator/weapons systems operator behind. Fifty dedicated training versions, the Mk 3CT and 3DT, were converted from standard Mk 3s.

The Avro Canada CF-100 Mk 1 prototype used Rolls-Royce Avon turbojets, replaced on production models by the Canadian Orenda 2 turbojet. On later versions the more powerful Orenda 8, 11 and 14 were used.

The definitive CF-100 Mk 5 model introduced a larger tailplane and increased wingspan, coupled with more powerful Orenda 14 turbojets, to improve high-altitude performance. Non-afterburning, each engine could provide 32.36 kN (7,278 lb thrust).



The Canuck Mk 5 shown here carried an all-weather APG-40 radar for the tracking of enemy bomber formations.

In the capacious ventral cavity under the forward fuselage, the Mk 5 could carry eight 12.7-mm (0.5-in) Colt-Browning machine guns or, alternatively, a tray containing 48 additional 70-mm (2.75-in) rockets.

Streamlined rocket pods mounted on each wingtip were first introduced on the CF-100 Mk 4. Each pod contained 29 unguided 70-mm (2.75-in) rockets, particularly effective in collision-course attacks on bomber formations. Alternatively, fuel tanks could be carried on the wingtip mounts.

Simple construction utilising tough materials gave the Canuck an exceptionally long flying life: the Royal Canadian Air Force's last few CF-100s were withdrawn as recently as 1981. Pilots enjoyed the plane's unrivalled stability and forgiving handling characteristics.

CF-100 Canuck Mk 5

Type: two-seat all-weather fighter

Powerplant: two 32.36-kN (7,278-lb-thrust) Orenda 11 or 14 turbojet engines

Maximum speed: 1046 km/h (650 mph) at 3050 m (10,000 ft)

Range: 3220 km (2,000 miles)

Service ceiling: 16,460 m (54,000 ft)

Combat radius: 1046 km (650 mph)

Weights: empty 10,478 kg (23,100 lb); maximum take-off 16,783 kg (37,000 lb)

Armament: 29 x 70-mm (2.75-in) 'Mighty Mouse' folding-fin aircraft rockets (FFAR) in each wingtip pod (48 additional FFAR or eight machine guns on some versions)

Dimensions:

span	17.68 m (58 ft)
length	16.48 m (54 ft 1 in)
height	4.74 m (15 ft 7 in)
wing area	54.90 m² (591 sq ft)

COMBAT DATA

MAXIMUM SPEED

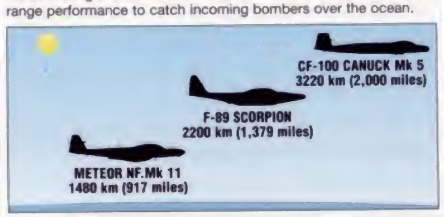
Straight-wing, all-weather fighters were heavy and ungainly machines compared to lightweight air-superiority fighters such as the F-104 and MiG-17, but were just as deadly in their own role.

ARMAMENT

Old-fashioned machine-gun armament was something of a weakness in the 1950s. Many MiG-15s in Korea returned to base after being hit by bullets from F-86 Sabres.

RANGE

For defending the North American continent, the CF-100 had a good range performance to catch incoming bombers over the ocean.



Canadian-built jets

■ **CANADAIR SILVER STAR:** A licenced-built version of the Lockheed T-33 with a Nene engine, this aircraft served as an advanced trainer with the RCAF in Canada and Europe.

■ **CANADAIR SABRE:** A Canadian-built F-86, the Sabre served with no fewer than 16 RCAF squadrons until replaced by the CF-100. The Sabre served in Europe and the UK in the early 1950s.

■ **AVRO CANADA CF-105 ARROW:** The intended replacement for the CF-100, the Arrow would have been the most potent interceptor of the 1960s but for its cancellation in February 1959.

■ **CANADAIR CF-104:** Canada began to licence-produce the Lockheed Starfighter after the cancellation of the CF-105. Later, these aircraft were tasked with strike/reconnaissance.

BELL

UH-1B/C IROQUOIS

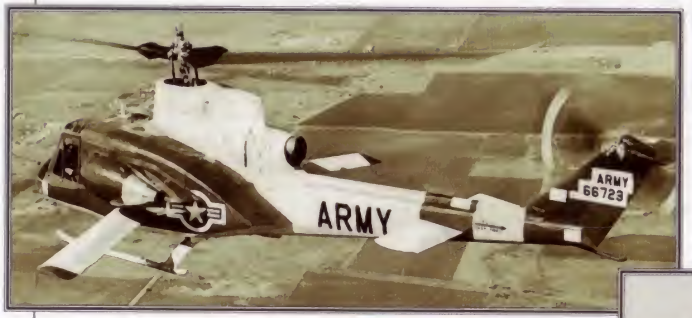
● Airborne jeep ● Multi-role helicopter ● NATO workhorse

Bell's Model 204 formed the basis for one of the most successful series of helicopters ever built. Flown for the first time in October 1956, it was designated XH-40, then HU-1, by the US Army (who called it the 'Huey'), before a designation change to HU-1A Iroquois. The HU-1B introduced a more powerful engine and the HU-1C had a new rotor system. Later still the HU- designation was changed to UH-. Variants were built by Agusta in Italy.

▲ *A door-gunner rides 'shotgun' with his M60 as a pair of 'Hueys' fly over the Delta region in Vietnam. To many people, the war in Southeast Asia was symbolized by images of the UH-1.*

PHOTO FILE

BELL UH-1B/C IROQUOIS



▲ High-speed bird
Several test configurations were used on the 'Huey', increasing the speed to 402 km/h (250 mph).

▼ Overseas success
Built under licence by Agusta in Italy as the AB 204, this 'Huey' serves in the anti-submarine role. Early versions of the UH-1 remain in service throughout Europe.

Anti-tank missiles ▶
The 'Huey' was employed in the development of the first air-to-ground missile for the US Army, which was used in Vietnam.

▲ Navy rescue
This TH-1L uses its sling hoist during a demonstration at Ellyson Field, Pensacola, Florida.

▲ Weapons platform
An Italian example demonstrates the offensive capabilities of the UH-1 by lifting off with two pylon-mounted machine guns and 21 rockets.

FACTS AND FIGURES

- Four prototype YUH-1Bs were ordered in June 1959, with the first flight taking place in the following April.
- A total of 1010 UH-1Bs were produced in Italy, Japan and the United States.
- The YUH-1B set an unofficial world speed record of 357 km/h (222 mph) in May 1964.
- Differences between the B and C models included a modified rotor system, wider rotor blades and a larger fin.
- The 'Huey' was the first helicopter to see widespread use as a gunship.
- The Royal Australian Air Force was the first non-US customer for eight UH-1Bs.

PROFILE

Bell's ubiquitous 'Huey'

The turbine engine was one of the keys to the Model 204's success. Mounted on the cabin roof just behind the gearbox, it left the cabin unencumbered and provided the performance required by the US Army.

Early UH-1Bs retained the UH-1A's 716-kW (960-hp) T53 engine, but an 820-kW (1,100-hp) powerplant soon became the standard. The new model was delivered from March 1961 and could be armed with rocket pods and machine guns carried on the sides of the cabin. UH-1Bs were also built by Fuji in Japan and Agusta in Italy. Agusta models included the AB 204AS anti-submarine variant for the Italian and Spanish navies, plus civil AB 204Bs with Lycoming T53, General Electric T58 or Rolls-Royce Gnome engines.

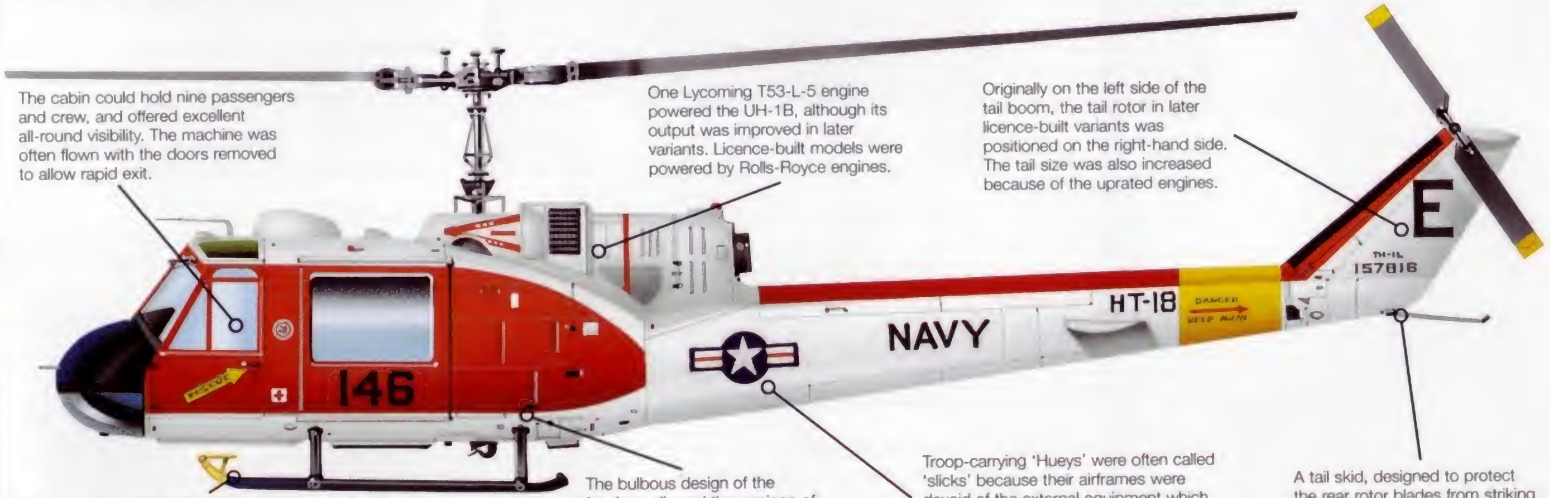
The UH-1C, which flew in September 1965, used a new rotor system with 'door hinges' and wider blades. This provided more lift, enabling the fuel load to be increased and improving the machine's manoeuvrability and speed. Variants of the UH-1C, with new designations, were used by the US Air Force, Navy and Marine Corps in the training, rescue and assault roles.

Above: This is one of six test YH-40s seen during a proving flight. There were few differences between these and the first production 'Hueys'.

Below: The glossy overall olive drab, with a yellow tail band and white lettering, soon gave way to dull green when the 'Huey' entered combat.

TH-1L

Pictured in red and white training colours, this TH-1L, the navy designation for the 'Huey', is used for pilot training. This involves flying from aircraft carriers and over-water navigation.



The cabin could hold nine passengers and crew, and offered excellent all-round visibility. The machine was often flown with the doors removed to allow rapid exit.

One Lycoming T53-L-5 engine powered the UH-1B, although its output was improved in later variants. Licence-built models were powered by Rolls-Royce engines.

Originally on the left side of the tail boom, the tail rotor in later licence-built variants was positioned on the right-hand side. The tail size was also increased because of the uprated engines.

Two skids supported the UH-1 on the ground. Although less complex than wheeled landing gear, their use restricted the helicopter's movement once it had landed.

The bulbous design of the fuselage allowed the carriage of stores on external pylons, so as not to restrict the internal load.

Troop-carrying 'Hueys' were often called 'slicks' because their airframes were devoid of the external equipment which reduced performance; this name has been used throughout the UH-1's service.

A tail skid, designed to protect the rear rotor blades from striking the ground during landing, was positioned on the end of the boom.

UH-1C

Type: single-engined multi-role utility helicopter

Powerplant: one 820-kW (1,100-hp) Lycoming T53-L-11 turboshaft engine

Maximum speed: 238 km/h (148 mph) at sea level

Initial climb rate: 427 m/min (1,400 fpm)

Range: 615 km (382 miles) with auxiliary fuel

Service ceiling: 3505 m (11,500 ft)

Weights: empty 2300 kg (5,070 kg); maximum take-off 4309 kg (9,500 lb)

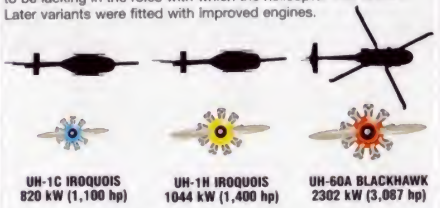
Dimensions:

rotor diameter	13.41 m (44 ft)
length	12.98 m (42 ft 7 in)
height	3.84 m (12 ft 7 in)
rotor disc area	141.26 m² (1,521 sq ft)

COMBAT DATA

POWER

Although the Huey was the first practical transport helicopter to see widespread military use, the power of the early models was found to be lacking in the roles with which the helicopter was tasked. Later variants were fitted with improved engines.



UH-1C IROQUOIS 820 kW (1,100 hp) | UH-1H IROQUOIS 1044 kW (1,400 hp) | UH-60A BLACKHAWK 2302 kW (3,087 hp)

MAXIMUM PAYLOAD

The early variants of the UH-1, although capable of lifting an acceptable load, required improvement. The advent of more powerful engines in later variants allowed an increased payload, although this was still restricted by the cabin size. The knowledge that was gained during the development of the 'Huey' was incorporated into the purpose-built Blackhawk.

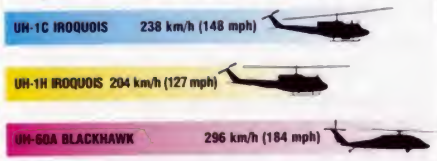
UH-1C IROQUOIS 1361 kg (3,000 lb)

UH-1H IROQUOIS 1759 kg (3,878 lb)

UH-60A BLACKHAWK 3629 kg (8,000 lb)

MAXIMUM SPEED

The UH-1B's relatively light load meant that its performance was superior to that of later models, which became much heavier because of operational and design changes. The twin-engined Blackhawk offered improved performance in a streamlined fuselage while retaining the capability to carry large loads.



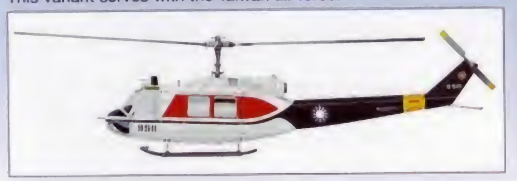
UH-1C IROQUOIS 238 km/h (148 mph)

UH-1H IROQUOIS 204 km/h (127 mph)

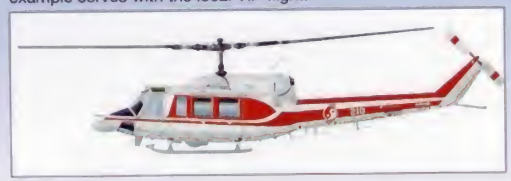
UH-60A BLACKHAWK 296 km/h (184 mph)

Improving the breed

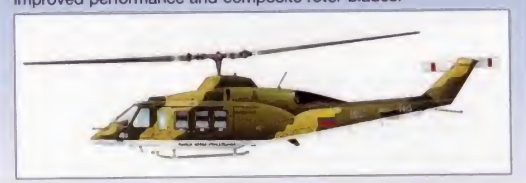
■ **UH-1H:** An improvement of the UH-1B design, advances included increased lifting capability and an enlarged cabin area. This variant serves with the Taiwan air force.



■ **MODEL 212:** Offering the reliability of an improved twin engine and a weather radar located in the nose, this Singaporean example serves with the local VIP flight.



■ **MODEL 214ST:** Possessing little commonality with earlier designs, this Venezuelan 'Huey' features a stretched cabin, improved performance and composite rotor blades.



BLACKBURN

BUCCANEER

● Low-level strike ● Anti-ship attack ● First Gulf War laser-bomber

One of those classics of aviation, the Blackburn Buccaneer was a warplane that pilots loved to fly and which was highly respected by its opponents. In its heyday it was the world's most advanced low-level, high-speed strike aircraft. Even at the end of its career it remained an immensely strong machine, capable of carrying just about any tactical bomb, rocket or missile used in modern air combat.

▲ *Blasting off from HMS* Ark Royal, *a Buccaneer sets off on a strike. The aircraft was designed to be a powerful threat to the Soviet navy, especially its 'Sverdlov'-class cruisers.*

PHOTO FILE

BLACKBURN BUCCANEER

▲ Touchdown
Early Buccaneers were powered by unreliable Gyron Junior engines. This made the final moments of a carrier landing somewhat perilous, if a pilot had to apply power to 'go around' again.

▼ Bombs away
Long-range bombing attacks were the Buccaneer's trademark. Although this bomb is conventional, the 'toss' delivery was designed for a nuclear weapon.

◀ Bush striker
South Africa was the only export success for the Buccaneer. These aircraft were used in action in long-range strikes, often at treetop height. They also carried South Africa's secret nuclear bombs; many experts estimated that five bombs existed.

▼ At home on the floor
The Buccaneer was designed to perform at very low altitude. Pilots took full advantage of this, and often carried out practice attacks while flying as low as 15 m (50 ft).

▲ Test aircraft
This brightly coloured example, XW986, was operated on test flights for many years by Britain's Royal Aircraft Establishment.

FACTS AND FIGURES

- The prototype Blackburn N.A. 39 made its initial flight on 30 April 1958.
- The 209th and last Buccaneer was delivered to the RAF on 6 October 1977.
- No. 801 Squadron of the Royal Navy was the first operational unit, embarking on HMS *Ark Royal* in January 1962.
- Buccaneers serving with RAF Germany were equipped with nuclear bombs.
- Buccaneers served as laser designators in the Gulf War in 1991.
- South African Buccaneers were acquired for maritime strike, but saw action in the guerrilla war in Namibia and Angola.

PROFILE

The king of long-range strike

Conceived in 1952, the Buccaneer was revolutionary – a carrier warplane designed to attack enemy warships at wavetop level, staying beneath hostile radar coverage. After surface-to-air missiles were introduced in the late 1950s, the Buccaneer was not just an innovation, but also a necessity. Seven versions of this brilliant strike warplane were built for Britain and South Africa. Buccaneers were designed to operate from the aircraft-carriers of the Royal Navy, but spent most of their career flying from land bases.

Developed in great secrecy, the Buccaneer was a powerful machine with superb low-level performance. Although designed with seaborne attacks in mind, its tough airframe was ideal for coping with the rapidly weaving high-*g* flight paths demanded by the terrain-following nature of its primary low-level attack role.

Despite being consigned to history, the final chapter of the Buccaneer story was written during Operation Desert Storm, when the sturdy old bombers were used with great success to designate targets for laser-guided weapons dropped from Tornados of the Royal Air Force.

Armed with a wing-mounted practice bomb pod, an RAF Buccaneer heads towards a bombing range. In well-trained hands the Buccaneer was a very accurate ground-attacker.

Buccaneer S.Mk 2

Type: two-seat carrier-capable low-level strike aircraft

Powerplant: two 49.38-kN (11,106-lb-thrust) Rolls-Royce RB.168-1A Spey Mk 101 turbofans

Maximum speed: 1038 km/h (645 mph) at 50 m (164 ft)

Combat radius: 1750 km (1,087 miles) (hi-lo-hi)

Service ceiling: 13,000 m (42,650 ft)

Weights: empty 13,600 kg (29,983 lb); loaded 28,123 kg (62,000 lb)

Armament: 7250 kg (15,984 lb) of bombs, rockets, anti-ship or air-to-surface missiles

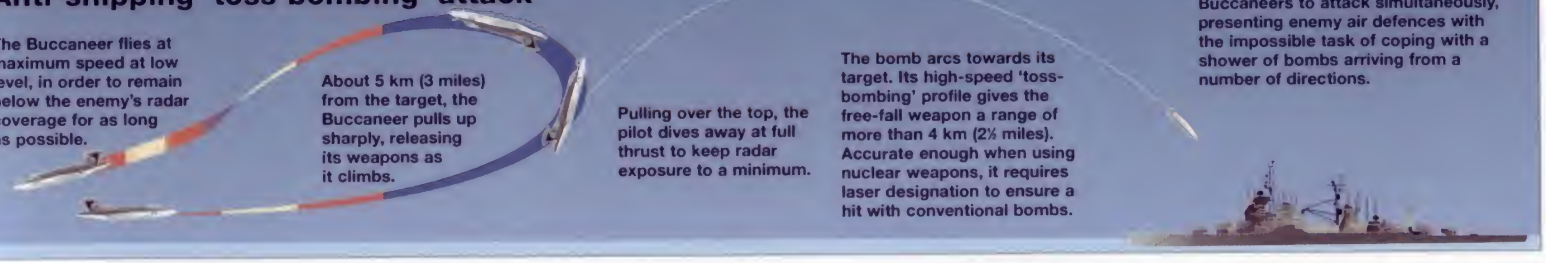
Dimensions:

span	13.41 m (44 ft)
length	19.33 m (63 ft 5 in)
height	4.95 m (16 ft 3 in)
wing area	47.82 m² (515 sq ft)

BUCCANEER S.MK 2B

RAF Buccaneers based in Germany in the 1970s and 1980s wore this green-grey colour scheme. The Buccaneer carried a variety of bombs, including 'Paveway' laser-guided weapons, for this role.

Anti-shipping 'toss bombing' attack



COMBAT DATA

SPEED AT SEA LEVEL

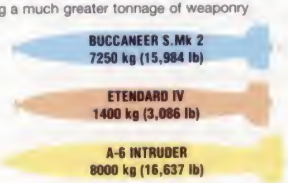
The Buccaneer's powerful engines and immensely strong airframe were designed for the lowest of low-level flight. It was one of the fastest combat jets in the world when carrying a heavy warload in the thick, resistant air at sea level.

RANGE

Buccaneers carried a large amount of fuel in their portly fuselages. When later variants dropped internal bomb-carrying capacity in favour of a bomb-bay fuel tank, they were more capable of longer range strikes than most other carrier-capable jets.

ARMAMENT

Originally designed to carry a relatively small bombload internally at high near-sonic speeds, the Buccaneer was soon found to be capable of hoisting a much greater tonnage of weaponry on four underwing hardpoints. It could match the American Grumman A-6 Intruder, although it lacked the American jet's sophisticated all-weather weapons delivery avionics.



BOEING

B-50/KB-50 SUPERFORTRESS

● Nuclear role ● Boeing's last piston-engined bomber ● Tanker conversions

▲ *As the ultimate development of the B-29, the B-50 was the last of the USAF's piston-engined bombers. It also performed pioneering work as a tanker, but was rapidly overtaken by the jet age.*

For a brief period the Boeing B-50 Superfortress was the backbone of the US Strategic Air Command (SAC). A heavy bomber, tasked with the delivery of the first nuclear bombs in the US Cold War arsenal, it was developed from the B-29, but incorporated new materials and much more powerful engines. In 1949 the B-50 set a record by flying nonstop around the world, and in the 1950s it stood alert, armed with nuclear weapons, for several years.

PHOTO FILE

BOEING B-50/KB-50 SUPERFORTRESS

Triple-point tanker ▶
An F-100 Super Sabre, an F-101 Voodoo and a B-66 Destroyer refuel simultaneously from the three hoses of a KB-50.

▲ Tanker conversions
Replacing the underwing fuel tanks with jet engines and adding hose units produced the KB-50.

▲ Final role
All KB-50Ks (such as the one pictured above) were converted from TB-50Hs.

▲ The first B-50
Boeing changed the B-29D designation to B-50A to ensure funding for the 'new' bomber.

Pure bomber ▶
The B-50D had a single-piece nose section and 2650-litre (700-US gallon) underwing fuel tanks.

FACTS AND FIGURES

- The B-50 can be distinguished from the similar B-29 by its taller tailfin and underwing fuel tanks.
- In total, 350 production B-50s and one prototype were built for the US Air Force.
- Boeing's B-50 made its maiden flight on 25 June 1947.
- After being delivered to SAC, more than 6000 work hours were needed to modify the B-50 to accommodate nuclear bombs.
- The B-50 began reaching SAC squadrons in June 1948.
- B-50s were briefly grounded because of rudder hinge problems.

PROFILE

Boeing's last piston-engined bomber

The Boeing B-50 began life as an improved B-29. Too late for World War II but just in time for the Cold War, the B-50 was capable of hauling atomic bombs and was expected to fly long-range missions. On 2 March 1949 the B-50 'Lucky Lady II' completed the first nonstop round-the-world flight, covering a distance of 37,742 km (23,452 miles) in 94 hours and 1 minute.

The B-50 was plagued by early problems. Its bomb-bay, as initially designed, was inadequate for the heavy, plutonium-based Type III nuclear bombs of the 1940s. It had the largest and most powerful reciprocating engine ever installed in an operational warplane and was prone to engine malfunctions. Early B-50s also suffered from metal fatigue. All of these problems were eventually solved, but, by this time, SAC was receiving the more capable B-36, B-47 and B-52 bombers.

Many B-50s undertook reconnaissance missions around the periphery of the Soviet Union, while others were used to train SAC crews, or acted as weather reconnaissance machines. The majority of B-50s were converted into tankers, and the last aircraft flew during the Vietnam War.

Above: Seen in February 1955, this WB-50D is one of 36 B-50D bombers stripped of weapons systems and used for weather reconnaissance. The last one was replaced by a WB-47 in 1967.

Above: Serial number 49-391 was the last B-50D to be built and is seen here after being converted to a KB-50J. Even with jet boost the KB-50 struggled to keep up with contemporary military jets. The last KB-50 left service in 1965.

B-50A Superfortress

Type: four-engined heavy bomber

Powerplant: four 2610-kW (3,500-hp) Pratt & Whitney R-4360-35 Wasp Major turbocharged radial piston engines

Maximum speed: 620 km/h (385 mph)

Cruising speed: 378 km/h (235 mph)

Range: 7483 km (4,650 miles)

Service ceiling: 11,278 m (37,000 ft)

Weights: empty 36,764 kg (81,051 lb); maximum take-off 76,389 kg (168,409 lb)

Armament: 12 12.7-mm (0.5-in) machine guns and one 20-mm (0.79-in) cannon; 9072-kg (20,000-lb) bombload

Dimensions:

span	43.05 m (141 ft 3 in)
length	30.18 m (99 ft)
height	9.96 m (32 ft 8 in)
wing area	161.55 m² (1,739 sq ft)

RB-50B

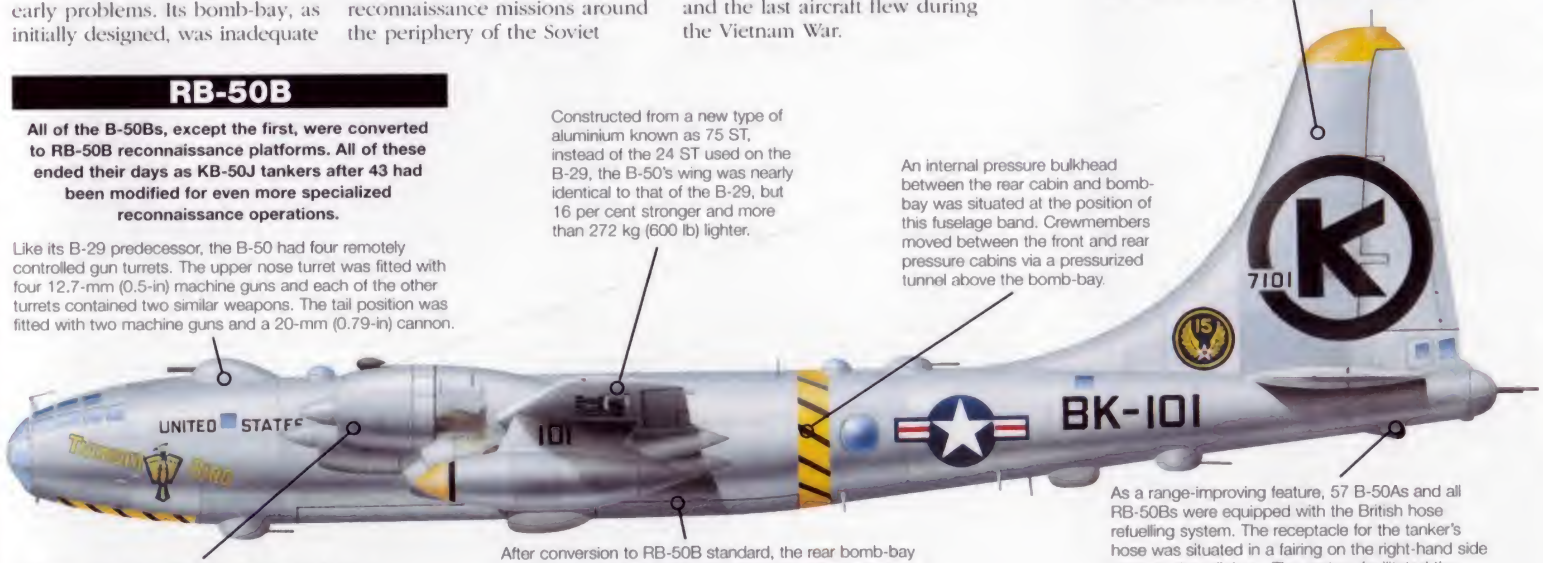
All of the B-50Bs, except the first, were converted to RB-50B reconnaissance platforms. All of these ended their days as KB-50J tankers after 43 had been modified for even more specialized reconnaissance operations.

Like its B-29 predecessor, the B-50 had four remotely controlled gun turrets. The upper nose turret was fitted with four 12.7-mm (0.5-in) machine guns and each of the other turrets contained two similar weapons. The tail position was fitted with two machine guns and a 20-mm (0.79-in) cannon.

Constructed from a new type of aluminium known as 75 ST, instead of the 24 ST used on the B-29, the B-50's wing was nearly identical to that of the B-29, but 16 per cent stronger and more than 272 kg (600 lb) lighter.

An internal pressure bulkhead between the rear cabin and bomb-bay was situated at the position of this fuselage band. Crewmembers moved between the front and rear pressure cabins via a pressurized tunnel above the bomb-bay.

As it was heavier than the B-29, the B-50 required a larger fin to maintain directional stability. The vertical tail could be folded down so that the aircraft could be stored in an average-sized USAF hangar.



Four-row 28-cylinder R-4360 engines produced a 59 per cent power increase over those of the B-29.

After conversion to RB-50B standard, the rear bomb-bay could accommodate extra crewmembers, plus cameras and electronic equipment.

As a range-improving feature, 57 B-50As and all RB-50Bs were equipped with the British hose refuelling system. The receptacle for the tanker's hose was situated in a fairing on the right-hand side beneath the tailplane. The system facilitated the nonstop B-50A circumnavigation of the world.

B-50 in action

IN-FLIGHT REFUELLING: Early methods of air-to-air refuelling were complicated and could often be dangerous.

AROUND THE WORLD: By refuelling from a KB-29P tanker, the 'Lucky Lady II' flew non-stop around the world. Many RB-50Bs used this hose method of refuelling as standard.

NUCLEAR BOMBING: The primary role of the B-50A/D was the long-range delivery of free-fall nuclear weapons. The aircraft were soon considered obsolete in this role, however.

THREE-POINT TANKER: KB-50J/K aircraft could trail three hoses and simultaneously refuel three probe-equipped aircraft. Here two FJ4 Furies and an F-8 Crusader are being refuelled.

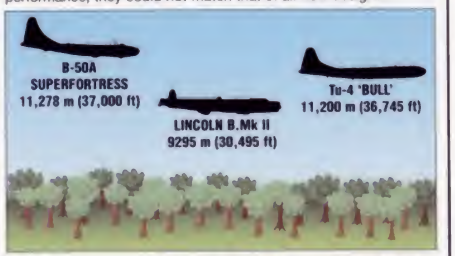
COMBAT DATA

MAXIMUM BOMBLOAD

A 9979-kg (22,000-lb) bombload for the Lincoln was an unusual mission using a single 'earthquake bomb'. Its bombload was usually similar to that of the B-50A. The Tu-4 was a Soviet copy of the B-29.

SERVICE CEILING

Both the Avro Lincoln and B-50A represented extreme developments of wartime designs. While they offered good performance, they could not match that of all-new designs.



RANGE

Although the B-50A offered long range, the range of the 'D' version was exceptional. The Lincoln could achieve the figure shown only when carrying a reduced bombload of 3000 kg (6,614 lb). Tupolev could not match the range of the B-50 with its Tu-4.

BOEING

C/KC-97 STRATOFREIGHTER

● B-29 development ● In-flight refuelling tanker ● Transport

▲ *Using the wings and other major components of the B-29, Boeing was able to develop a large transport which was to become the basis of the USAF tanker fleet.*

By combining major sections of the B-29 with an all-new upper fuselage, Boeing produced the Model 367, which was first flown on 9 November 1944. Known to the US Air Force as the XC-97 Stratofreighter, this aircraft was to be the first in a long line of transports, tankers and tanker/transports based on the C-97. The refuelling techniques adopted from the KB-29P and refined on the KC-97 remain much the same on Boeing's modern KC-135.

PHOTO FILE

BOEING C/KC-97 STRATOFREIGHTER

▼ Israeli transport
A YC-97 was supplied to Israel as payment for the cost of maintaining US aircraft, and one KC-97F and eight KC-97Gs were delivered later. They flew military missions in civilian markings.

▲ Fast-jet refuelling
KC-97Ls remained in US Air National Guard service until 1977. Many of them were fitted with auxiliary J47 turbojet engines so that they could reach the speeds required for refuelling fighters.

Tanker transport versatility ▶
The KC-97G gave the USAF an aircraft which was capable of carrying freight or passengers without removing its refuelling system. This was the most common model.

▼ Nose radome
When the C-97A entered service it introduced a distinctive chin radome, which housed an AN/APS-42 search radar. All subsequent aircraft featured radar.

▲ Wartime prototype
The first of three XC-97s flew in 1944. Its clamshell rear cargo doors and ramp can be clearly seen in this picture.

FACTS AND FIGURES

- On 9 January 1945 the first XC-97, carrying a 9072-kg (20,000-lb) payload, flew from Seattle to Washington DC in 6 hours and 3 minutes.
- With its pressurized cabin, the XC-97 was able to cruise at 9144 m (30,000 ft).
- The YC-97 used engine nacelles developed for, but never fitted to, the B-29.
- A single YC-97A flew in the Berlin airlift, carrying cargo such as coal, which was loaded by conveyor belt.
- MC-97C was the designation of casualty evacuation aircraft in the Korean War.
- New systems allowed the KC-97G to dispense with a radio operator.

PROFILE

Booming success for Boeing

Boeing chose the simplest structural route in order to produce the C-97. The lower fuselage lobe was of similar diameter to that of the B-29, while the upper fuselage also had a circular cross-section but was of greater diameter. Combining these gave Boeing two circular-section cabins to pressurize, which was a much easier proposition than it would face if producing an elliptical pressurized fuselage of the same size.

In January 1942 a US Army Air Force order resulted in the construction of three XC-97 prototypes, which led, in turn, to the production of 10 YC-97 service test aircraft. These were to prove the C-97 concept and eventually led to production of 50 C-97As.

Although the C-97A proved to be an exceptional freighter, various efforts were made to improve it, including trials with three experimental KC-97As fitted with refuelling booms taken from KB-29Ps. The aircraft proved to be a highly capable tanker, with the KC-97G becoming the most widely built model of the series.

Several KC-97 variants were made and the ultimate KC-97L served with Air National Guard units until 1977.

Above: Between March and August 1965, the KC-97Gs of the Wisconsin Air National Guard were brought up to KC-97L standard.

Below: Ten service test aircraft were ordered in July 1945 for US Army Air Force trials. They had a larger fuel capacity than the XC-97.

KC-97G Stratofreighter

Type: long-range transport and in-flight refuelling tanker

Powerplant: four 2610-kW (3,500-hp) Pratt & Whitney R-4360-59B radial piston engines

Maximum speed: 604 km/h (375 mph)

Cruising speed: 483 km/h (300 mph)

Climb rate: 50 min to 6096 m (20,000 ft)

Range: 6920 km (4,300 miles)

Operating ceiling: 9205 m (30,200 ft)

Weights: empty 37,421 kg (82,500 lb); maximum take-off 79,379 kg (175,000 lb)

Accommodation: 96 troops or 69 stretcher patients, plus refuelling system

Dimensions:

span	43.05 m (141 ft 3 in)
length	33.63 m (110 ft 4 in)
height	11.66 m (38 ft 3 in)
wing area	164.34 m² (1,769 sq ft)

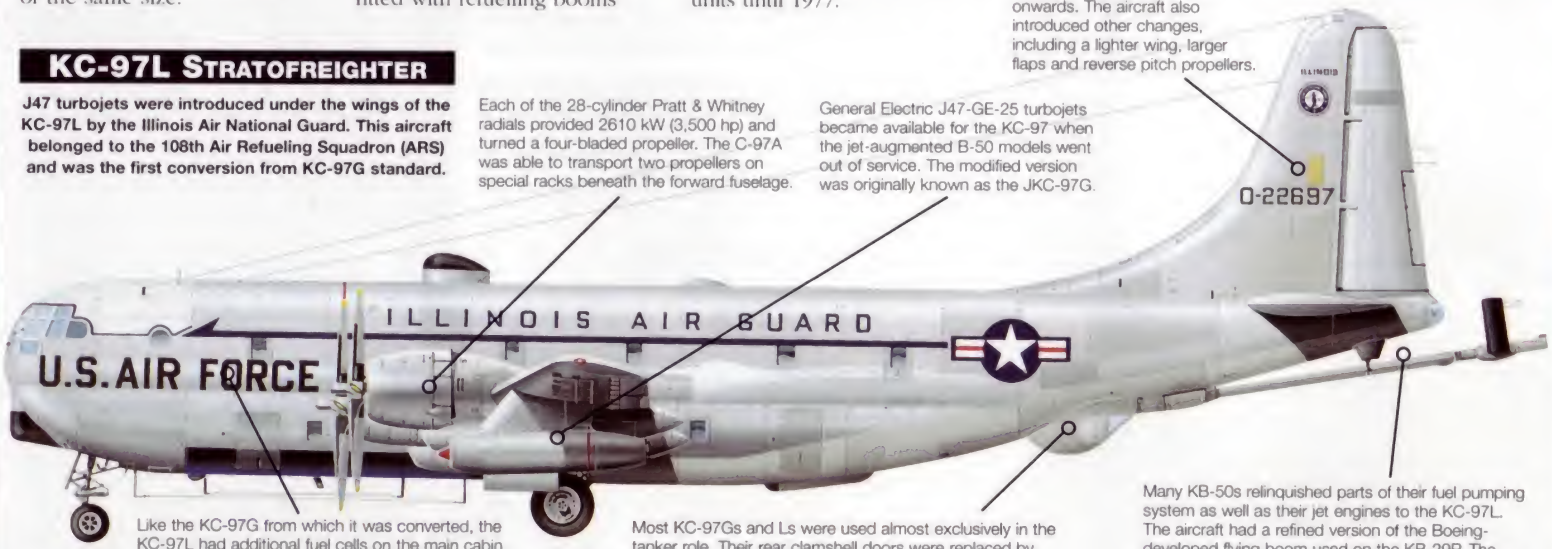
KC-97L STRATOFREIGHTER

J47 turbojets were introduced under the wings of the KC-97L by the Illinois Air National Guard. This aircraft belonged to the 108th Air Refueling Squadron (ARS) and was the first conversion from KC-97G standard.

This high B-50-style fin was introduced from the YC-97A onwards. The aircraft also introduced other changes, including a lighter wing, larger flaps and reverse pitch propellers.

Each of the 28-cylinder Pratt & Whitney radials provided 2610 kW (3,500 hp) and turned a four-bladed propeller. The C-97A was able to transport two propellers on special racks beneath the forward fuselage.

General Electric J47-GE-25 turbojets became available for the KC-97 when the jet-augmented B-50 models went out of service. The modified version was originally known as the JKC-97G.



Like the KC-97G from which it was converted, the KC-97L had additional fuel cells on the main cabin floor, as well as a substantial freight capacity.

Most KC-97Gs and Ls were used almost exclusively in the tanker role. Their rear clamshell doors were replaced by the boom operator's position and observation windows.

Many KB-50s relinquished parts of their fuel pumping system as well as their jet engines to the KC-97L. The aircraft had a refined version of the Boeing-developed flying boom used on the KB-29P. The boom of the modern KC-135 has changed very little.

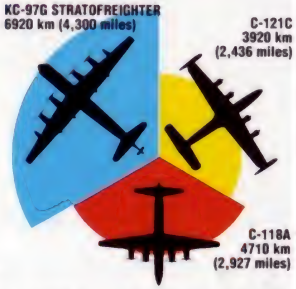
ACTION DATA

CRUISING SPEED

The KC-97G had a slower cruising speed than contemporary transport aircraft in USAF service. This proved to be a problem when the Stratofreighter was required to refuel fighters and other jet aircraft. As a result, J47 turbojets were fitted.

RANGE

Exceptional range was demonstrated by the KC-97G, especially when flying in the transport role. The aircraft was capable of being used over vast distances without removal of its tanking equipment.



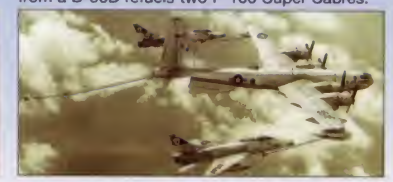
PASSENGERS

Lockheed's C-121C and Douglas's C-118A, based on the Super Constellation and DC-6 airliners, respectively, were able to fly only as transports. The C-121C had greater seating capacity than the KC-97G. The Stratofreighter retained all of its tanking equipment, however, and allowed the extra flexibility of combined transport and tanking missions with reduced payload.

Boeing tanker chronology

■ **KB-29P SUPERFORTRESS:** Boeing pioneered the use of the flying-boom refuelling system on the KB-29P.

■ **KB-50:** Some 136 B-50s were modified to tanker configuration. Here an early conversion from a B-50D refuels two F-100 Super Sabres.



■ **KC-135 STRATOTANKER:** Boeing's KC-135 has become a classic military aircraft design and will be in service for many years.

■ **MODEL 707:** As second-hand 707 airliners became available, several air arms cheaply converted them into tankers.

BOEING

B-47 STRATOJET

● All-jet bomber ● Swept-wing design ● Bicycle undercarriage

▲ *Operating from distant bases was part of the SAC requirement; to some crews of the B-47 it meant the cold conditions of Alaska. Here a crew prepare its aircraft for take-off.*

Graceful and beautiful, the Boeing B-47 Stratojet was an aircraft with a deadly mission. For years, the B-47 was the backbone of the US Strategic Air Command (SAC), poised and ready to leap into the skies carrying a lethal cargo of atomic bombs in response to a nuclear attack. SAC had nearly 2000 Stratojets in service in the mid-1950s, the most potent bomber force ever assembled.

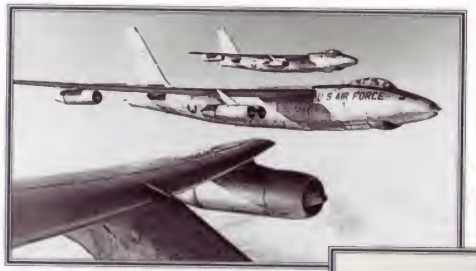
PHOTO FILE

BOEING B-47 STRATOJET

Constant vigil ▶
With the need to launch at a moment's notice, B-47 crews were required to maintain a 24-hour alert. Here a Stratojet pilot waits for the call that will launch his bomber into the night's sky. Practice operations were undertaken at all hours.

◀ Combined operations
The nose of a KC-97 tanker partly obscures a B-47 positioned behind. These aircraft operated in close co-operation: the tanker supplied fuel to the bomber, allowing the Stratojet to strike targets at a greater distance. SAC pioneered routine IFR operations.

Long range ▶
A B-47 commander brings his aircraft in to formate with a KC-97 tanker. The refuelling receptacle was positioned on the nose of the bomber.



▲ Fighter handling
B-47 pilots found the bomber had exceptional handling for formation flying. It was also able to accomplish loops and rolls.

Late variants ▶
A late production Stratojet displays the bomber's unusual undercarriage design.

FACTS AND FIGURES

- The first B-47 flew on 17 December 1947, the anniversary of the Wright Brothers' first powered flight in 1903.
- A Stratojet set a transatlantic speed record from the United States to England.
- The first B-47 production contract was for 10 aircraft, costing $30 million in all.
- Production of the B-47 had amounted to 2041 of all variants when assembly work ended in February 1957.
- Some 440 Stratojets were built for non-bombing duties such as reconnaissance.
- The B-47 strongly influenced the design of the Boeing B-52 Stratofortress.

PROFILE

SAC's first jet bomber

Above: A sight repeated right across the continental United States: two SAC Stratojets await their alert call to action.

The Boeing B-47 Stratojet defeated several rivals to become the US Air Force's choice as its principal strategic bomber of the 1950s. Stratojets began to arrive at SAC bases in October 1951. The Stratojet was the first swept-wing jet bomber ever produced. It was appealing to the eye and had breathtaking performance, but the cramped cockpit arrangement was awkward and crew fatigue on long missions was a problem.

Many B-47s stayed on nuclear alert, ready to launch with their deadly cargo of atomic bombs. Some B-47s participated in Reflex deployments between the United States and Great Britain, in support of worldwide strategic readiness. In 1959, Stratojets participated in Operation Oil Burner, practising low-level strike runs to penetrate below enemy radar detection while still accurately delivering nuclear weapons to their strategic targets.

Despite the fact that it was stressful on crews, the B-47 was much-loved by nearly all who maintained and flew it. Eventually replaced by the B-52 Stratofortress, the B-47 remained in operation with SAC until the 1960s. The last bomber version was retired on 11 February 1966, but the reconnaissance RB-47 variants were to remain on duty with the 55th SRW until 29 December 1967.

B-47E Stratojet

Type: long-range strategic bomber

Powerplant: six General Electric J47-GE-25/25A turbojets, each developing 32.03 kN (7,204 lb thrust) with water injection

Maximum speed: 975 km/h (606 mph) at 4970 m (16,300 ft)

Cruising speed: 806 km/h (501 mph) at 11,735 m (38,500 ft)

Ceiling: 12,345 m (40,500 ft)

Range: 6437 km (4,000 miles)

Weights: empty 36,630 kg (80,755 lb); maximum take-off 89,893 kg (198,180 lb)

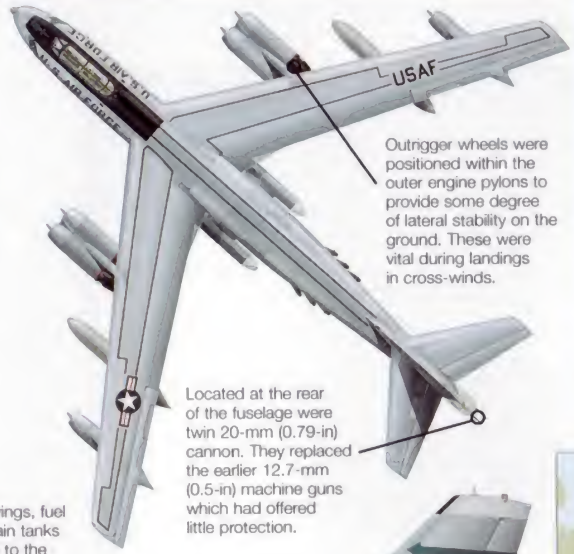
Armament: two M24A1 20-mm (0.79-in) cannon, each with 350 rounds of ammunition, in radar-directed, remotely controlled tail turret, plus up to 9071 kg (20,000 lb) of bombs carried internally

Dimensions:

span	35.36 m (116 ft)
length	33.48 m (109 ft 10 in)
height	8.51 m (27 ft 11 in)
wing area	132.66 m² (1,428 sq ft)

B-47E-I Stratojet

This B-47 Stratojet displays the late scheme of white anti-flash undersides, used to protect aircraft from the explosion of their own atomic bombs. SAC's blue ribbon insignia is painted on the nose.



Outrigger wheels were positioned within the outer engine pylons to provide some degree of lateral stability on the ground. These were vital during landings in cross-winds.

Located at the rear of the fuselage were twin 20-mm (0.79-in) cannon. They replaced the earlier 12.7-mm (0.5-in) machine guns which had offered little protection.

The 35-degree swept-back wing was thin and had an extremely high aspect ratio. It proved to have very fine aerodynamic efficiency. The wings were constructed so that, during manoeuvres, they could flex up to 3 m (10 ft), allowing the bomber to accomplish loops and barrel rolls during certain attack procedures.

Because of the thin wings, fuel was carried in two main tanks positioned above and to the rear of the weapons bay. After testing, the bomb-bay was made smaller than that of the early A models, reflecting advances in bomb design.

The two pilots sat in tandem under a Plexiglass canopy. Visibility was excellent, although the second pilot's forward view was restricted.

A tandem or 'bicycle' arrangement was used for the main undercarriage, each set of wheels being installed either side of the bomb bay.

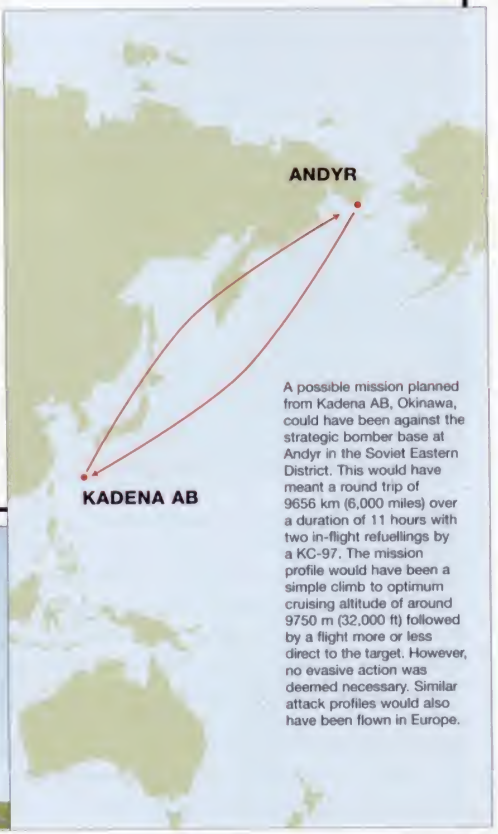
Later B-47E models did away with the internal jet-assisted take-off (JATO) units. Instead, the units were incorporated on an external rack which could be jettisoned following take-off. By using this procedure a larger bombload could be carried.

Stratojet bombing mission

1 In-flight refuelling: So that the B-47 Stratojet could attack targets at great distance, the aircraft would refuel from a KC-97 tanker aircraft.

2 High performance: In its day the B-47 was able to outrun enemy fighters, although some SAC reconnaissance versions did return to base after missions having received damage from MiG-15s.

3 Bomb run: Capable of delivering a vast range of weapons, the Stratojet would use a variety of manoeuvres to avoid nuclear blast when dropping its ordnance.



A possible mission planned from Kadena AB, Okinawa, could have been against the strategic bomber base at Andyr in the Soviet Eastern District. This would have meant a round trip of 9656 km (6,000 miles) over a duration of 11 hours with two in-flight refuellings by a KC-97. The mission profile would have been a simple climb to optimum cruising altitude of around 9750 m (32,000 ft) followed by a flight more or less direct to the target. However, no evasive action was deemed necessary. Similar attack profiles would also have been flown in Europe.

BOEING

B-52 STRATOFORTRESS (SAC)

● Eight-engined nuclear bomber ● Still in service

Stratofortresses were the mighty sword of the USAF's Strategic Air Command (SAC). From 1955 until 1991 the B-52 was on 'nuclear alert', sitting at the end of the runway armed with nuclear bombs and with crew poised nearby. SAC crews knew that a ballistic missile launched by a Soviet submarine could reach their base within 25 minutes. If they were to fight back, this was all the time they had to get into the air on what could be a one-way mission.

▲ *By 1958 the B-52 was the most important component in the world's most powerful military force. US foreign policy was based on deterrence; SAC could deliver a nuclear weapon anywhere.*

PHOTO FILE

BOEING B-52 STRATOFORTRESS (SAC)

▼ Hound Dog carrier
As ICBMs (intercontinental ballistic missiles) became more important, the B-52 took on the launching of stand-off weapons such as the jet-powered AGM-28 Hound Dog missile,

▲ Air-to-air refuelling
SAC also operated a large fleet of Boeing KC-135 tankers, which provided its 'anywhere in the world' capability.

▼ Tandem seating
The first two B-52s had a tandem two-seat cockpit, unlike production aircraft, which had a side-by-side arrangement.

Nuclear deterrence ▶
B-52s eventually lost their primary role in the SAC deterrent to ICBMs. This B-52 is pictured flying over an Atlas missile in California.

◀ Tailless but airborne
On loan to Boeing at the time, this B-52H lost most of its 12-m (40-ft) tailfin on a low-level test flight. Amazingly, it landed safely.

FACTS AND FIGURES

- The second B-52 built, YB-52 serial number 49-23, was the first to fly and is now at the USAF Museum in Ohio.
- The prototype for the B-52 series made its first flight on 15 April 1952.
- B-52Ds over Vietnam carried a load equivalent to eight World War II B-17Gs.
- In January 1957 three B-52Bs flew nonstop around the world (39,147 km/ 24,325 miles) in 45 hours and 19 minutes.
- The three pre-production B-52As built in 1954 cost a huge $29 million each.
- The 744th and last B-52 bomber entered service with SAC on 26 October 1962.

PROFILE

SAC's ultimate nuclear bomber

Boeing's B-52 Stratofortress was designed to drop atomic bombs from the stratosphere. The biggest USAF bomber of its era, the eight-engine B-52 dropped real 'nukes' during atmospheric tests in the Pacific in 1956 and 1962. For nearly four decades B-52 crews stood ready to drop nuclear bombs in anger, if necessary. Indeed, until the late 1960s aircraft equipped with live nuclear weapons were maintained on airborne alert.

With the advent of surface-to-air missiles in the 1960s the B-52 successfully shifted from high- to low-level weapon delivery, but the war in Vietnam brought a different mission – high-level tactical bombing with old-fashioned 'iron' bombs.

Built in seven production versions, the B-52 has been in service for more than 40 years and has outlived Strategic Air Command itself. Although its importance as a weapon system has been steadily downgraded, a number are projected to remain in service until at least 2020, making it the longest-serving warplane in history.

Twenty-seven RB-52Bs were built from 1955 and were able to carry a pod in the bomb-bay with four to six camera positions and/or electronic reconnaissance equipment and two operators. The 'convertible' concept was abandoned in 1956.

B-52D Stratofortress

Type: six-seat strategic bomber

Powerplant: eight 53.82-kN (12,105-lb-thrust) Pratt & Whitney J57-P-19W turbojet engines

Maximum speed: 893 km/h (555 mph) at altitude

Climb rate: 750 m/min (2,460 fpm)

Combat range: 11,730 km (7,290 miles)

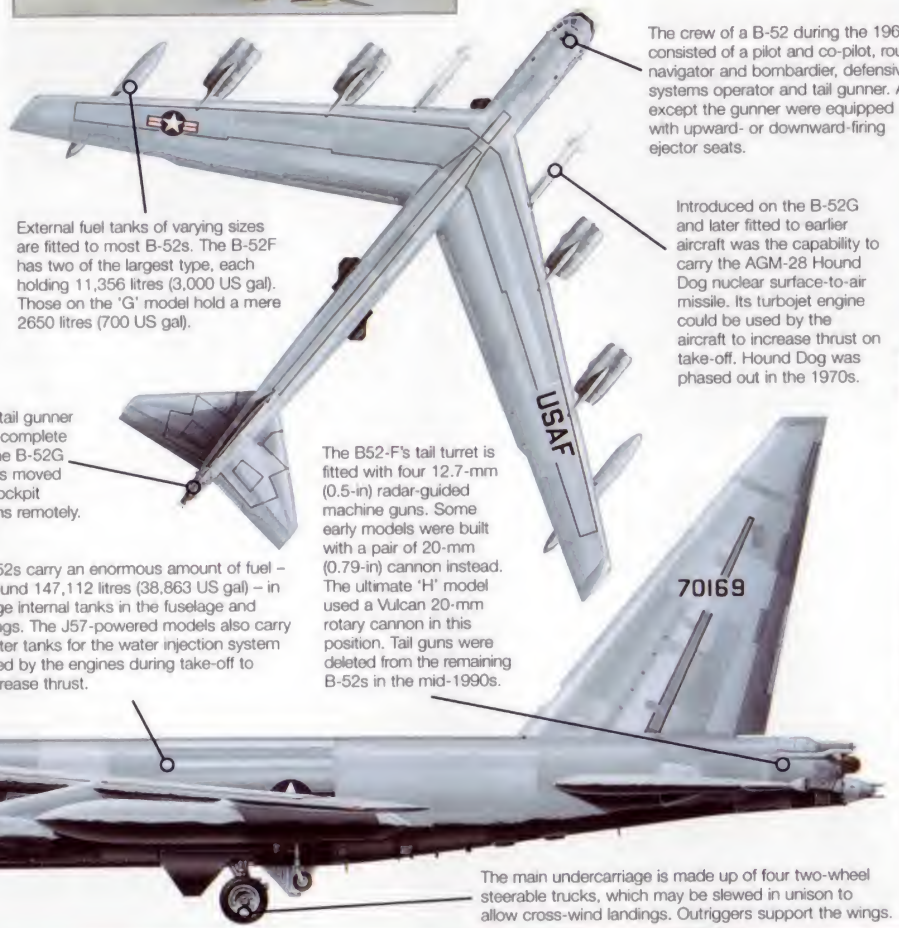
Service ceiling: 11,600 m (38,000 ft)

Weights: empty 74,893 kg (165,111 lb); maximum 204,117 kg (450,000 lb)

Armament: four 12.7-mm (0.5-in) machine guns in tail turret and up to 27,215 kg (60,000 lb) of bombs internally and on external racks

Dimensions:

span	56.39 m (185 ft)
length	47.73 m (156 ft 7 in)
height	14.73 m (48 ft 4 in)
wing area	371.60 m² (4,000 sq ft)



The crew of a B-52 during the 1960s consisted of a pilot and co-pilot, route navigator and bombardier, defensive systems operator and tail gunner. All except the gunner were equipped with upward- or downward-firing ejector seats.

External fuel tanks of varying sizes are fitted to most B-52s. The B-52F has two of the largest type, each holding 11,356 litres (3,000 US gal). Those on the 'G' model hold a mere 2650 litres (700 US gal).

Introduced on the B-52G and later fitted to earlier aircraft was the capability to carry the AGM-28 Hound Dog nuclear surface-to-air missile. Its turbojet engine could be used by the aircraft to increase thrust on take-off. Hound Dog was phased out in the 1970s.

B-52F Stratofortress

Phased out in the early 1970s, B-52Fs were the first SAC bombers to serve over Vietnam; 57-0169 of the 320th Bomb Wing flew 68 missions over Vietnam from Guam and is shown here after its return to the States.

In an emergency the tail gunner is able to jettison the complete turret to escape. In the B-52G and H the gunner was moved from the turret to a cockpit position, firing his guns remotely.

The B52-F's tail turret is fitted with four 12.7-mm (0.5-in) radar-guided machine guns. Some early models were built with a pair of 20-mm (0.79-in) cannon instead. The ultimate 'H' model used a Vulcan 20-mm rotary cannon in this position. Tail guns were deleted from the remaining B-52s in the mid-1990s.

Early production B-52s had a conventional side-by-side cockpit for the two pilots, with two other crewmembers seated behind facing aft. The fifth and sixth crewmen sat on a lower level facing forward.

All B-52s except the 'H' model are powered by eight Pratt & Whitney J57 turbojets as fitted to numerous other types, such as F-8 and F-100 fighters, A-3 bombers and U-2 reconnaissance aircraft.

B-52s carry an enormous amount of fuel – around 147,112 litres (38,863 US gal) – in large internal tanks in the fuselage and wings. The J57-powered models also carry water tanks for the water injection system used by the engines during take-off to increase thrust.

The radome under the cockpit contains the bombing radar scanner.

The main undercarriage is made up of four two-wheel steerable trucks, which may be slewed in unison to allow cross-wind landings. Outriggers support the wings.

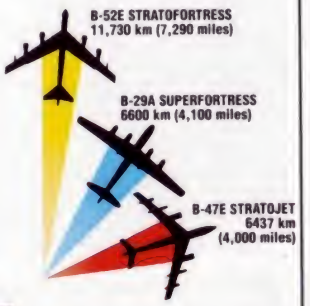
COMBAT DATA

UNIT COST

The rising cost of military aircraft was largely a result of advancing technology. The larger the order for a new aircraft, the lower the unit cost. The three experimental B-52As cost a huge $29 million each, while the mass-produced B-52Es were a 'mere' $6 million.

RANGE

Interestingly, the B-47E actually had a shorter range than the World War II-vintage B-29. However, the B-47 was a much faster aircraft and could be refuelled in the air. The much larger B-52 had a considerably enhanced fuel capacity compared to the others.



MAXIMUM SPEED

At the end of World War II the B-29 was one of the fastest four-engined bombers. The jet age increased speeds considerably, the B-47 being able to hold its own against fighters of the early 1950s. Speed was less important by the time the B-52 was produced; range and load-carrying capacity were paramount.

Boeing's strategic bombers

■ **B-17 FLYING FORTRESS:** Taking to the air in 1935, the B-17 was built in enormous numbers after the United States entered World War II. Most of its missions took place over Europe.

■ **B-29 SUPERFORTRESS:** The B-29 was an advanced aircraft when it first flew in 1942. It was to bear the brunt of the bombing campaign over Japan; one delivered the first atomic bomb.

■ **B-50 SUPERFORTRESS:** Production of this more powerful development of the B-29 began in 1945. Although they saw action over Korea, most were converted to tankers as the KB-50.

■ **B-47 STRATOJET:** Predecessor of the B-52 and the first swept-wing jet bomber built in any numbers, the six-engined B-47 served SAC from 1951. At its peak 1800 were in service.

BOEING

EC/RC-135

● Strategic reconnaissance ● Intelligence gatherer ● Command post

For decades the Boeing RC-135, the aerial espionage cousin of the KC-135 tanker, has been vanguard of the secret world of reconnaissance, giving its crews hours of boring routine interrupted by seconds of sheer terror. During tensions with the Soviet Union, the 'spy in the sky' RC-135 often flew within a kilometre of Moscow's territory. The EC-135 is similar, but is packed with radios to act as a flying command post during a nuclear war.

▲ *The EC-135 is based on the same aircraft as the RC-135, but contains different equipment. Most of this is for communications with other US military forces. There is usually a general on board who can control the war from the air.*

PHOTO FILE

BOEING EC/RC-135

◀ High-tech telephonist
The job of most of the crew on the EC-135 is to make communication connections with ground stations or other aircraft.

▼ Command post
The airframe of the EC-135 is festooned with antennas for the many radios.

▼ Missile watchers
The two RC-135S Cobra Ball aircraft specialize in tracking and photographing missiles. A unique feature is the black painted wing, which reduces glare for photography of re-entry vehicles. Aerials are used to gather data from missile launchers.

▼ Inflight refuelling
Tanking is vital to the RC-135's ability to stay on station for many hours at a time.

▼ The 'Hoover'
This RC-135U is known as the 'Hoover' because of its ability to 'suck up' every electronic signal. Only two remain in service, flying from Offut AFB, Nevada.

FACTS AND FIGURES

- The systems operators in the RC-135 are known as Ravens.
- The first RC-135 reconnaissance craft became operational in August 1966.
- Strategic Air Command RC-135s flew more than 6200 intelligence-gathering sorties during the Vietnam War.
- EC-135s have a trailing antenna which can be reeled out to a length of 10 km (6 miles) for communication with submarines.
- Several EC-135s carried a special nose radome to track the Apollo spacecraft.
- The RC-135S can hunt for enemy mobile missile launchers in wartime.

PROFILE

America's super snooper

The Boeing RC-135 strategic reconnaissance aircraft is the offspring of the Boeing KC-135 Stratotanker and is closely related to the spectacularly successful Boeing 707 airliner. The RC-135 was designed as an electronic eavesdropper and it collects SIGINT (signals intelligence), including an enemy's radar emissions, radio communications or missile telemetry.

The closely related EC-135 was an airborne command post for Strategic Air Command, and the E-6 Mercury still provides the same service for the US Navy's missile submarines.

RC-135s of the US Air Force's 55th Wing deploy worldwide to snoop on potential adversaries in global trouble spots. During the Cold War, they flew closer to the Soviet Union more often than any other Western aircraft.

During Operation Desert Storm, the RC-135 gathered vital intelligence on Saddam Hussein's forces. Using radios, radar and electronic equipment to spy on potential opponents, the RC-135 continues to be vital to the overseas interests of the United States.

Below: The nose of the RC-135 is covered with bulges containing intelligence-gathering equipment.

Above: Despite the end of the Cold War, the RC-135 fleet is as important as ever to the United States. During the wars in Vietnam and the Gulf it proved it was just as good at collecting intelligence in a tactical war as it was in the type of superpower stand-off for which it had been designed.

RC-135V

Type: multi-engined long-range reconnaissance aircraft

Powerplant: four 80.07-kN (18,009-lb-thrust) Pratt & Whitney TF-33-P-9 (JT3D-3B) turbojets

Maximum speed: 990 km/h (615 mph) at 10,000 m (32,800 ft)

Operational radius: 4300 km (2,672 miles)

Service ceiling: 12,375 m (40,600 ft)

Weights: empty 47,650 kg (105,050 lb); loaded 144,000 kg (317,466 lb)

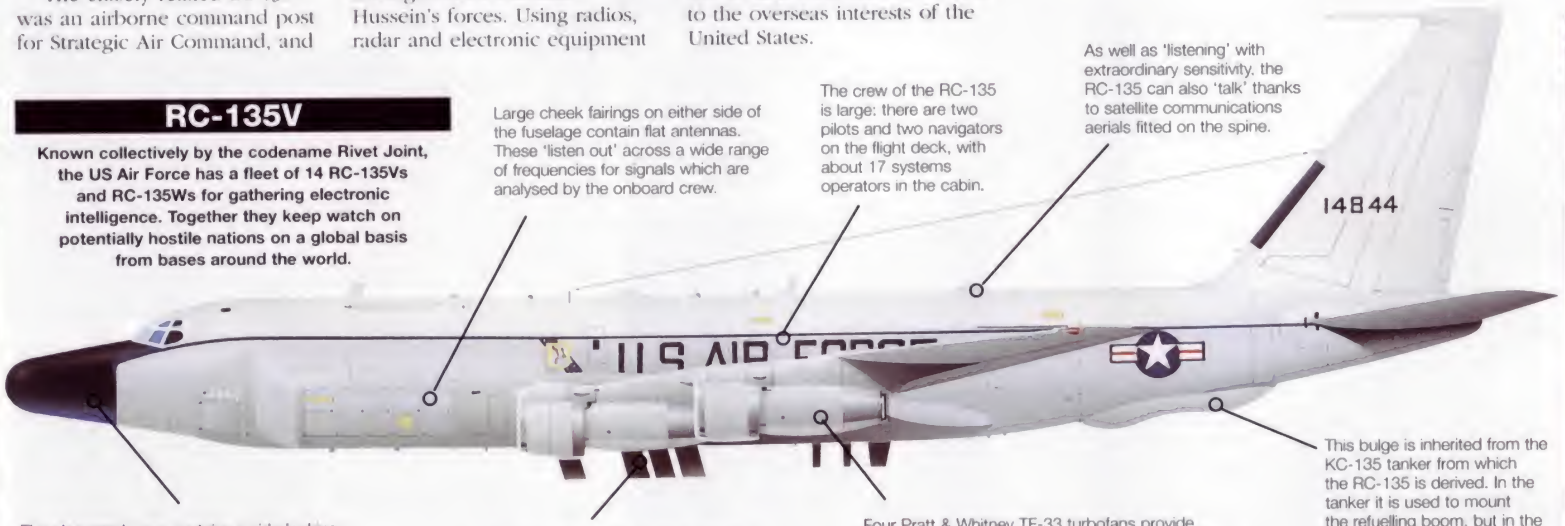
Accommodation: reconnaissance versions of the Stratotanker carry electronic sensors and monitoring crews of up to 35

Dimensions:

span	39.88 m (130 ft 10 in)
length	41.53 m (136 ft 3 in)
height	12.70 m (41 ft 8 in)
wing area	226.00 m² (2,433 sq ft)

RC-135V

Known collectively by the codename Rivet Joint, the US Air Force has a fleet of 14 RC-135Vs and RC-135Ws for gathering electronic intelligence. Together they keep watch on potentially hostile nations on a global basis from bases around the world.



Large cheek fairings on either side of the fuselage contain flat antennas. These 'listen out' across a wide range of frequencies for signals which are analysed by the onboard crew.

The crew of the RC-135 is large: there are two pilots and two navigators on the flight deck, with about 17 systems operators in the cabin.

As well as 'listening' with extraordinary sensitivity, the RC-135 can also 'talk' thanks to satellite communications aerials fitted on the spine.

The elongated nose contains a side-looking radar, which provides an accurate picture of the coastline for precise navigation. This is very important when snooping close to a hostile country's airspace.

The RC-135V has a mass of large aerials under the fuselage. These are highly sensitive to electronic signals, and are used to pick up and record radars and communications.

Four Pratt & Whitney TF-33 turbofans provide adequate power and economic operation, but will be replaced in the next few years by more modern engines. Missile warning/jamming gear is often carried just above the engines to protect the RC-135.

This bulge is inherited from the KC-135 tanker from which the RC-135 is derived. In the tanker it is used to mount the refuelling boom, but in the RC-135 it incorporates yet more antennas. Some RC-135s also have a downward-facing camera in the bulge.

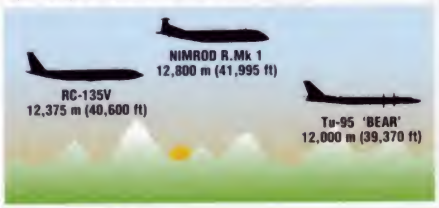
ACTION DATA

MAXIMUM SPEED

Compared to the main British and Russian intelligence gatherers, the RC-135 is faster. In the deadly game of strategic reconnaissance, however, endurance and equipment capability are the most telling factors.

SERVICE CEILING

The three aircraft have similar ceilings. Operations are normally undertaken at around 10,000 m (32,800 ft), at which height they are high enough to 'peer' a long way into the target territory.



RANGE

Designed as a long-range bomber, the Tu-95 'Bear' has exceptional endurance. For longer missions RC-135s are supported by aerial tankers providing inflight refuelling to prolong the sorties.

BOEING

B-52G/H STRATOFORTRESS

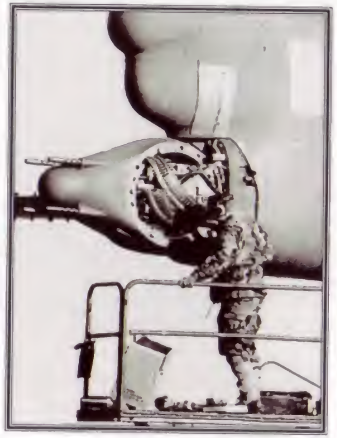
● Strategic bomber ● Nuclear/conventional weapons ● Global reach

Conceived as the giant silver sword of the United States Air Force Strategic Air Command, the B-52 Stratofortress was the biggest purely jet-powered bomber of its time, and has been flying for almost 50 years. Flown for decades on atomic alert, its only combat use has been the massive conventional bombing campaigns in Southeast Asia and the Persian Gulf.

▲ *Displaying its enormous wingspan, a B-52 gets airborne trailing a thick plume of smoke as its eight turbojet engines strain at full power to lift its 229,000 kg (504,860 lb) into the air.*

PHOTO FILE

BOEING B-52G/H STRATOFORTRESS



◀ Sting in the tail

Most versions of the B-52 had a fearsome rear defence of four '50-calibre' guns. These were aimed using the radar mounted above.

◀ Extending the range

By using inflight refuelling, the B-52 can cover any part of the globe from just a few bases. This veteran is seen on its way to Vietnam in 1972.

Modern day warrior ▶

Two fully laden B-52Gs launch from Riyadh in Saudi Arabia for another mission against massed Iraqi armoured divisions during the Gulf War of 1991.

◀ Nuclear deterrence

The B-52 has an important role as a launch platform for nuclear missiles. Here an SRAM is launched from the massive weapons bay.

A fistful of throttles ▶

The cockpit is dominated by the central engine control panel. Every dial and lever is multiplied eightfold.

FACTS AND FIGURES

- The B-52 has a crew of five, including two pilots, navigator, electronic warfare officer and bombardier.
- Boeing manufactured 744 'Buffs' and finished the last aircraft in October 1962.
- A B-52 can reach any target in the world within 18 hours.
- During Operation Desert Storm, B-52s flew 1624 missions, and dropped 5,829,000 kg (12,850,748 lb) of bombs.
- Each B-52 contains 90 km (56 miles) of electrical wiring.
- In 1959, three B-52Bs flew nonstop around the world in under 50 hours.

PROFILE

America's 'Big Stick'

The longest-serving frontline warplane in history, the B-52 Stratofortress was the right aircraft at the right time. It first flew on 15 April 1952 and became the backbone of the West's nuclear preparedness; had the need arisen, hundreds of B-52s would have headed for Russia to drop hydrogen bombs on key strategic targets.

The special 'Big Belly B-52D' could also carry 108 conventional bombs, and during the Vietnam War 129 B-52s of several models carried out the December 1972 'Christmas bombing', designed to force North Vietnam to the conference table.

Since then, the B-52 has been extensively modified. New engines and electronics have extended the life of the 'Buff' (Big Ugly Fat Fella) into the 1990s. B-52Gs flew the longest combat missions in history during Operation Desert Storm, from Louisiana to the Middle East. Today, B-52Hs have both nuclear and conventional roles.

The 'Buff' is one of the best-loved of all aircraft and can operate at high level or at very low level on terrain-avoidance under-the-radar missions.

During the 1991 Gulf War B-52s pounded Iraqi targets from as far afield as England and the British territory of Diego Garcia in the Indian Ocean.

'Buffs' can mount up to 24 340-kg (750-lb) or 454-kg (1,000-lb) high-explosive or cluster bombs on external wing pylons.

B-52H STRATOFORTRESS

Known in the USAF as the 'Cadillac', the B-52H is significantly upgraded compared to the early Stratofortresses. With more modern turbofan engines it outperforms its predecessors in both range and payload. Built to carry nuclear-tipped ballistic missiles, it is still a vital weapon in the USAF arsenal.

B-52H Stratofortress

Type: five-seat long-range strategic bomber

Powerplant: eight 75.62-kN (17,008-lb-thrust) Pratt & Whitney TF33-P-3 turbofans

Maximum speed: 958 km/h (595 mph) at 3096 m (10,160 ft)

Range: 16,000 km (9,942 miles)

Service ceiling: 16,765 m (55,000 ft)

Weights: empty 138,799 kg (306,000 lb); loaded 229,000 kg (504,860 lb)

Armament: one 20-mm (0.79-in) M61A1 tail cannon; 81 454-kg (1,000-lb) bombs, or 20 AGM-86 or AGM-129 cruise missiles, or four to six nuclear bombs

Dimensions:

span	56.39 m (185 ft)
length	49.05 m (160 ft 11 in)
height	12.40 m (40 ft 8 in)
wing area	271.60 m² (2,932 sq ft)

The radar-directed rear guns are controlled remotely by a gunner who aims via a screen in the forward cockpit.

The immensely strong wings of the B-52 not only support the eight engines, but are also filled with fuel, giving the 'Buff' enormous range.

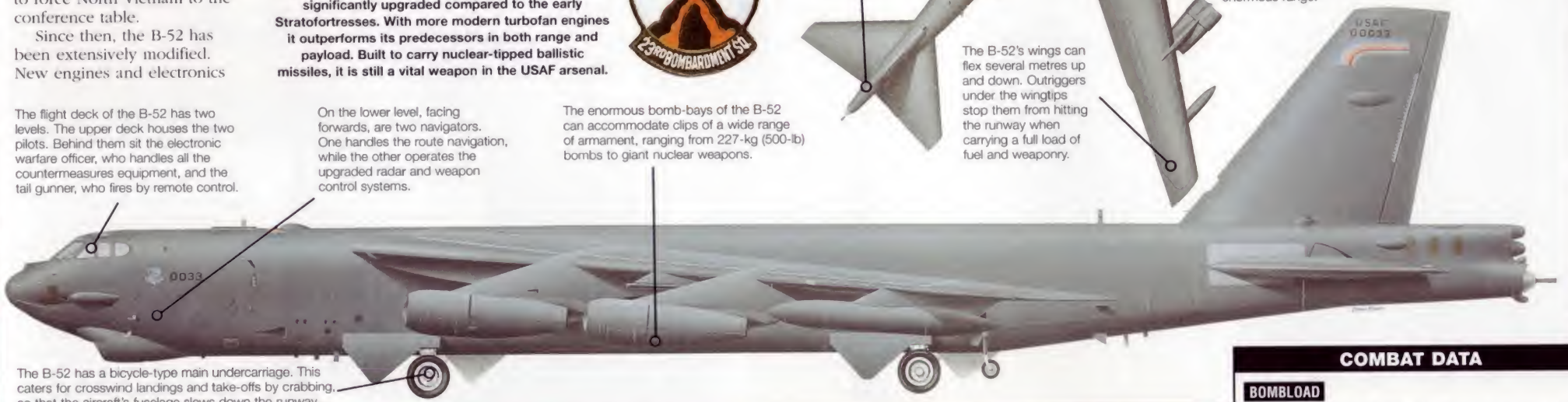
The B-52's wings can flex several metres up and down. Outriggers under the wingtips stop them from hitting the runway when carrying a full load of fuel and weaponry.

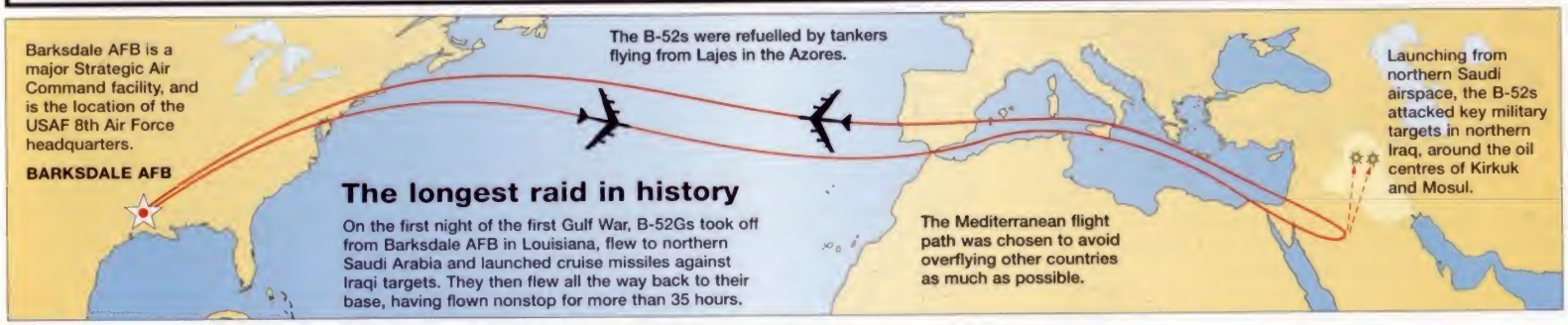
The flight deck of the B-52 has two levels. The upper deck houses the two pilots. Behind them sit the electronic warfare officer, who handles all the countermeasures equipment, and the tail gunner, who fires by remote control.

On the lower level, facing forwards, are two navigators. One handles the route navigation, while the other operates the upgraded radar and weapon control systems.

The enormous bomb-bays of the B-52 can accommodate clips of a wide range of armament, ranging from 227-kg (500-lb) bombs to giant nuclear weapons.

The B-52 has a bicycle-type main undercarriage. This caters for crosswind landings and take-offs by crabbing, so that the aircraft's fuselage slews down the runway.





The longest raid in history

On the first night of the first Gulf War, B-52Gs took off from Barksdale AFB in Louisiana, flew to northern Saudi Arabia and launched cruise missiles against Iraqi targets. They then flew all the way back to their base, having flown nonstop for more than 35 hours.

COMBAT DATA

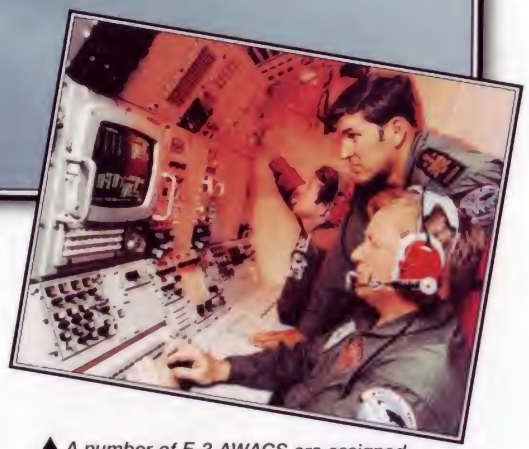
BOMBLOAD

The B-52H can carry a vast array of weaponry. Its load can include up to 20 nuclear cruise missiles or 81 free-fall bombs, as well as anti-ship missiles or conventional cruise missiles. Designed during the Cold War, the B-52 carries its bombload over a great range and would have penetrated into the heart of the Soviet Union if necessary.

BOEING

E-3 AWACS SENTRY

● Flying radar station ● Commands and controls the air battle

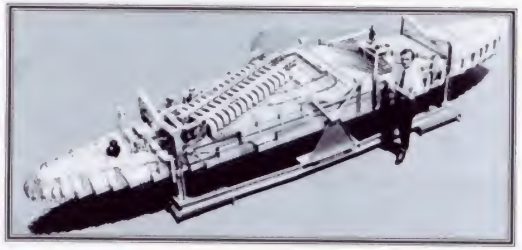


▲ *A number of E-3 AWACS are assigned to NATO. Radar operators, communications technicians and battle analysts from each member state serve aboard each Sentry aircraft.*

Boeing's E-3 Sentry is a flying radar station. This aerial headquarters patrols the skies and scans the military situation below, monitoring friendly and hostile aircraft. Inside the metal cocoon of the E-3's fuselage, technical experts work magic with radar and electronics to detect enemy warplanes, plot their course, and guide friendly fighters to shoot them down.

PHOTO FILE

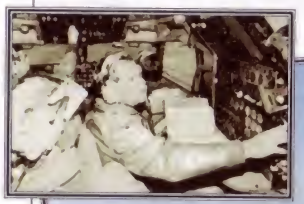
BOEING E-3 AWACS SENTRY



▲ **Giant radar**
This is the huge antenna for the APY-2 radar. On one side is the radar itself; on the other is the IFF equipment for detecting whether aircraft are friendly or hostile.

▲ **Flight deck**
E-3 pilots may expect to spend a good deal of time at their stations: AWACS missions often last 10 hours or more, flying basically a racetrack orbit.

▼ **Operator station**
The cabin of the E-3 is packed with consoles. From here, operators monitor air traffic on large screens which display output from the long-range radar.



▲ **Long endurance**
Inflight refuelling allows the E-3 to stay aloft for a day or more. On very long missions extra flight crew are carried to avoid overexhaustion.

◀ **NATO's air force**
In addition to American, British and French E-3s NATO also has its own AWACS squadron, crewed by airmen from the member nations.

FACTS AND FIGURES

- The Boeing E-3 Sentry took to the air for the first time on 5 February 1972.
- Originally, the Sentry was expected to be an eight-engined aircraft.
- The AWACS radar can see over the horizon, detecting enemy aircraft hundreds of kilometres away.
- In all, 68 AWACS were built for the USA, NATO, Saudi Arabia, Britain and France.
- The disc-shaped radar dome atop the AWACS is larger than many aircraft.
- The Sentry was the last version of the Boeing 707, which went out of production in 1991 after 37 years.

PROFILE

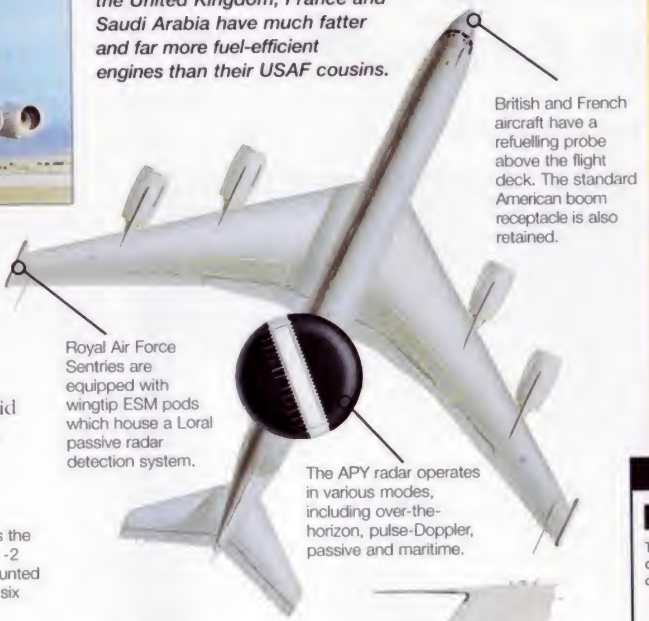
Eye in the sky

Getting the edge over the enemy by using a large aircraft for surveillance was a hot idea in 1955 when the Lockheed Super Constellation became the first Airborne Warning and Control System (AWACS). Today's E-3 is a modern AWACS aircraft which flies at jet speeds carrying up to 17 technicians who use the latest hi-tech wizardry.

To the pilots situated up front, the E-3 is an upscale version of the Boeing 707, the great and beautiful aircraft which revolutionized air travel. To the technicians who sit out back, however, the E-3 AWACS is the eyes and ears of the battlefield commander, watching, analysing and directing.

During Operation Desert Storm, 30 air-to-air victories were scored by Allied fighters who were guided into action by AWACS crews. With its long range and endurance, the E-3 Sentry can spy on an entire battlefield or, if necessary, an entire nation – as these aircraft did when keeping tabs on the conflict in Bosnia.

Versions of the Sentry built for the United Kingdom, France and Saudi Arabia have much fatter and far more fuel-efficient engines than their USAF cousins.



British and French aircraft have a refuelling probe above the flight deck. The standard American boom receptacle is also retained.

Royal Air Force Sentries are equipped with wingtip ESM pods which house a Loral passive radar detection system.

The APY radar operates in various modes, including over-the-horizon, pulse-Doppler, passive and maritime.

E-3A AWACS Sentry

Type: airborne warning and control system

Powerplant: four 93.36-kN (21,000-lb-thrust) Pratt & Whitney TF-33-P-100/100A turbofans or four 102.97-kN (23,160-lb-thrust) CFM-56 turbofans

Maximum speed: 853 km/h (530 mph) at 6096 m (20,000 ft)

Normal operating speed: 563 km/h (350 mph) at 12,192 m (40,000 ft)

Endurance: six hours, flying at 12,192 m (40,000 ft) a distance of 1609 km (1,000 miles) from base for a total mission time in excess of 11 hours

Service ceiling: 8850 m (29,035 ft)

Weights: empty 77,966 kg (171,886 lb); loaded 147,420 kg (325,006 lb)

Dimensions:

span	44.42 m (145 ft 9 in)
length	46.61 m (152 ft 11 in)
span	12.73 m (41 ft 9 in)
wing area	283.30 m² (3,049 sq ft)

E-3A AWACS Sentry

Introduced into USAF service in 1977, the Sentry was selected to equip a multinational NATO unit based in Germany under Luxembourg registration. The first of 18 aircraft was delivered to the NATO Airborne Early Warning Force in 1981.

Key to the E-3's capability is the Westinghouse AN/APY-1 or -2 radar. Its huge antenna, mounted above the fuselage, rotates six times per minute.

AWACS has a flight deck crew of four, comprising pilot/aircraft commander, co-pilot, navigator and flight engineer.

E-3s generally carry a mission crew of 16, under the overall mission commander. These include radar operators, communications specialists and weapons controllers.

USAF and NATO Sentries are powered by four Pratt & Whitney TF-33 turbofans. British, French and Saudi E-3s are powered by larger and more fuel-efficient CFM-56 engines.

In order to control the air battle, AWACS is fitted with 13 HF, VHF and UHF communications links controlled by the computerized and digitized J-TIDS (Joint Tactical Information Distribution System).

ACTION DATA

ENDURANCE

The E-3 Sentry's exceptional endurance means that it is capable of flying unrefuelled surveillance missions lasting six hours at distances in excess of 1600 km (1,000 miles) from its home base.

OPERATING ALTITUDE

The Sentry has a surprisingly modest service ceiling, being bettered by the smaller propeller-driven Hawkeye. Even so, at its working operating heights above 8000 m (26,250 ft) the E-3 can 'see' for several hundred kilometres.

RADAR RANGE

The Sentry's most important attribute is its amazing radar. Capable of detecting several thousand targets at extremely long range, it can also simultaneously direct and control 100 or more allied aircraft making intercepts.

Multi-mode radar control

PDNS: Pulse-Doppler Non-elevation Scan is the basic radar mode, used to measure the distance of airborne targets several hundred kilometres away.

MARITIME: Advanced signal processing systems allows AWACS to pick-out ship-sized targets amid the chaotic clutter of radar returns from the surface of the sea.

INTERLEAVED: AWACS can switch between modes several times per second. This allows the big aircraft to scan for aircraft and surface targets simultaneously.

BRITISH AEROSPACE

SEA HARRIER FRS.MK 1

● Deadly dogfighter ● Falklands attacker ● Vertical take-off

When the Sea Harrier went to war in the South Atlantic, the idea of a vertical take-off naval fighter was untested, and many thought it a joke. This remarkable 'jump jet' proved itself in battle, however, operating from ever-moving aircraft-carriers. The Sea Harrier shot down Mirages, Skyhawks and everything else in sight to become one of the great successes of the Falklands conflict.

▲ *Flt Lt Dave Morgan admires the 20-mm (0.79-in) cannon hole in his Sea Harrier's tail after the first raid of the Falklands campaign. Not one Sea Harrier was lost in air-to-air combat.*

PHOTO FILE

BRITISH AEROSPACE SEA HARRIER FRS.MK 1

▲ The 'Wish Me' weapon
Sea Harriers scored most of their kills with the AIM-9L Sidewinder. Pilots said all you had to do was to wish the opponent dead, hence the nickname.

▲ 'La Muerta Negra'
This name was bestowed on the Sea Harrier by Argentine pilots, who called it 'The Black Death' because of its almost mythical invincibility in air combat.

'Fox Two – Splash One Mirage!' ▶
An AIM-9L Sidewinder accelerates away, viewed through a Sea Harrier's head-up display. The missile accounted for 18 kills of Argentine aircraft in just 26 launches during the Falklands campaign.

▼ Task Force
Fighting so far from friendly airfields, and without a conventional aircraft-carrier, the Royal Navy Task Force relied totally on the Sea Harrier for its air superiority and ground-attack needs.

▲ Softening up the Argentines
Sea Harriers did much more than shoot down enemy aircraft – they also pounded the hapless troops with bombs and rockets. Here deck crew prepare to load MATRA rocket pods.

FACTS AND FIGURES

- The Sea Harrier logged 13,000 missions from ship decks before there was a single accident involving damage to an aircraft.
- During the Falklands conflict, assault ships and converted container vessels were used as landing platforms for the Sea Harrier.
- Blue Fox radar gives the Sea Harrier excellent air-to-air and air-to-ground capability.
- Sea Harriers destroyed 23 Argentine aircraft in air combat without loss.
- The 'ski-jump' found on carriers enables Harriers to take off with a full warload.

PROFILE

'Black Death' in the Falklands

'I locked my radar onto the leader, then began looking for others – I couldn't believe that a pair of fighters would come in alone like that. Their formation was poor, what the Americans call "Welded Wing", flying close together. They seemed aware of me but not of Paul.'

Lieutenant Steve Thomas and Flight Lieutenant Paul Barton of Britain's Royal Navy were flying Sea Harriers over the Falkland Islands on 1 May 1982 when they encountered a pair of Argentine Mirages.

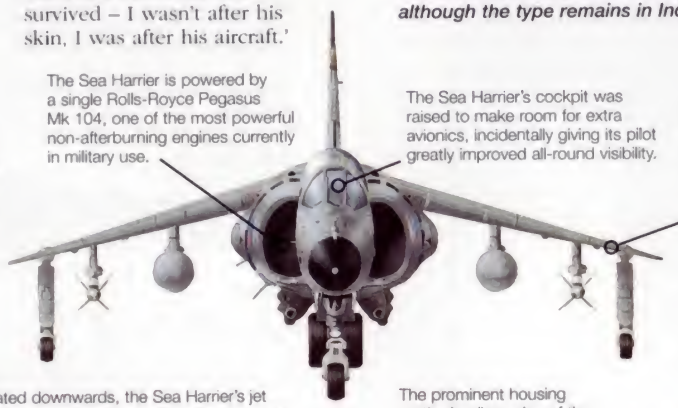
'This is the sort of thing one learns not to do on day one at the Tactical Weapons Unit,' Barton continues. 'With hindsight, it was obvious that the Number 2 was a rookie, woefully inexperienced and working hard just to hang on to his leader.

'The Argentinians were courageous and were good stick and rudder men. But their training and tactics were awful – I don't think the leader knew he was under attack until I fireballed his wingman – the first man ever shot down by a "jump jet". After the war I was delighted to learn that the rookie had survived – I wasn't after his skin, I was after his aircraft.'

The last Royal Navy Sea Harriers were retired in 2006, although the type remains in Indian service.

SEA HARRIER FRS.MK 1

Few aircraft have ever dominated aerial combat the way the Sea Harrier did over the Falklands. The skill and bravery of the Argentine pilots was undoubted, but they could not match the superior tactics, cool heads and tenacity of the Royal Navy pilots, nor the sheer fighting prowess of the Sea Harrier.



The Sea Harrier is powered by a single Rolls-Royce Pegasus Mk 104, one of the most powerful non-afterburning engines currently in military use.

The Sea Harrier's cockpit was raised to make room for extra avionics, incidentally giving its pilot greatly improved all-round visibility.

Sea Harriers set off for the Falklands in a light-grey scheme, but by the time combat was joined they were in overall dark sea grey. Their appearance led Argentine pilots to call the Sea Harrier 'La Muerta Negra' – the Black Death.

When rotated downwards, the Sea Harrier's jet nozzles lift the aircraft vertically, but when they are tilted backwards they propel the aircraft just like a conventional jet.

The prominent housing on the leading edge of the tailplane is for the Marconi Radar Warning Receiver, which alerts pilots to enemy detection systems.

The Ferranti Blue Fox radar is capable of both air-to-air and air-to-ground operation. The radar can detect a target, check its identity, calculate ranges, and lock missiles on.

Sea Harrier XZ457 is seen as it appeared at the end of the conflict, with kill markings for two Daggers and a Skyhawk.

The AIM-9L Sidewinder was the Sea Harrier's principal weapon in the South Atlantic.

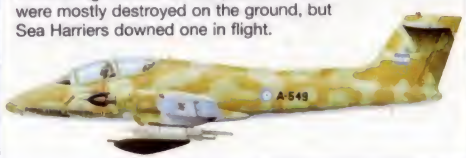
Small 'puffer' jets at the wingtips and tail provide control when the aircraft is hovering.

The Sea Harrier's prey

■ **MIRAGE III:** Although on paper the fastest and most capable of the Argentine jets, 11 Dassault Mirages and their Israeli-built Dagger copies were nevertheless shot down by Sea Harriers.

■ **A-4 SKYHAWK:** Dating back to the 1950s, the Skyhawk was one of the most successful of the Argentine attack jets. Sea Harriers destroyed eight in combat.

■ **FMA PUCARÁ:** Expected to have been a real danger to British troops, the Pucarás were mostly destroyed on the ground, but Sea Harriers downed one in flight.



Sea Harrier FRS.Mk 1

Type: carrier-based interceptor and strike fighter

Powerplant: one 93.85-kN (21,108-lb-thrust) Rolls-Royce Pegasus Mk 104 vectored-thrust turbofan

Maximum speed: 1185 km/h (736 mph)

Combat radius: 750 km (466 miles)

Service ceiling: 15,600 m (15,180 ft)

Weights: empty 5892 kg (12,990 lb); loaded 11,612 kg (25,600 lb)

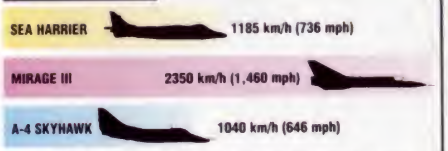
Armament: two 30-mm (1.18-in) ADEN cannon with 125 rounds each (optional); two AIM-9L Sidewinder missiles; Sea Eagle, Harpoon or other ordnance up to 3625 kg (7,990 lb)

Dimensions:

span	7.70 m (25 ft 3 in)
length	14.50 m (47 ft 7 in)
height	3.71 m (12 ft 2 in)
wing area	18.68 m² (201 sq ft)

COMBAT DATA

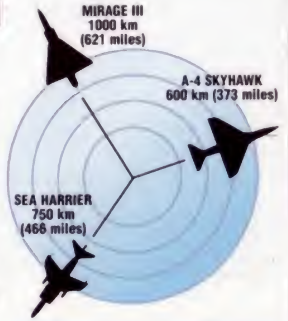
MAXIMUM SPEED



Although the Mirage was far faster than the Sea Harrier, it was operating at the limits of its range and could not use its fuel-hungry afterburners for more than a few seconds. As a result, it fell prey to the far more agile British jet.

COMBAT RADIUS

The Sea Harriers had an enormous advantage over the Argentine jets in that they were operating close to their carriers. The Mirages and Skyhawks were operating from bases 600 km (370 miles) away without the benefit of airborne refuelling, and the Skyhawks in particular had absolutely no fuel margin to engage in long dogfights.



AGILITY

Much of the Sea Harrier's success came from its advanced weapons and the superb combat training of its pilots. The jump jet was also extremely manoeuvrable, however, and had blistering acceleration which stood it in good stead in close-quarter combat.

CONVAIR

B-36 FICON

● Giant strategic bomber ● Reconnaissance mother-ship

The B-36 was America's most spectacular Cold War deterrent; 383 of these bombers were the backbone of the mighty Strategic Air Command from 1948 to 1959. The largest warplanes ever to fly in the West, they carried the biggest hydrogen bombs ever built and girdled the globe on nuclear alert or highly dangerous spying missions. At one stage they even carried their own fighter aircraft.

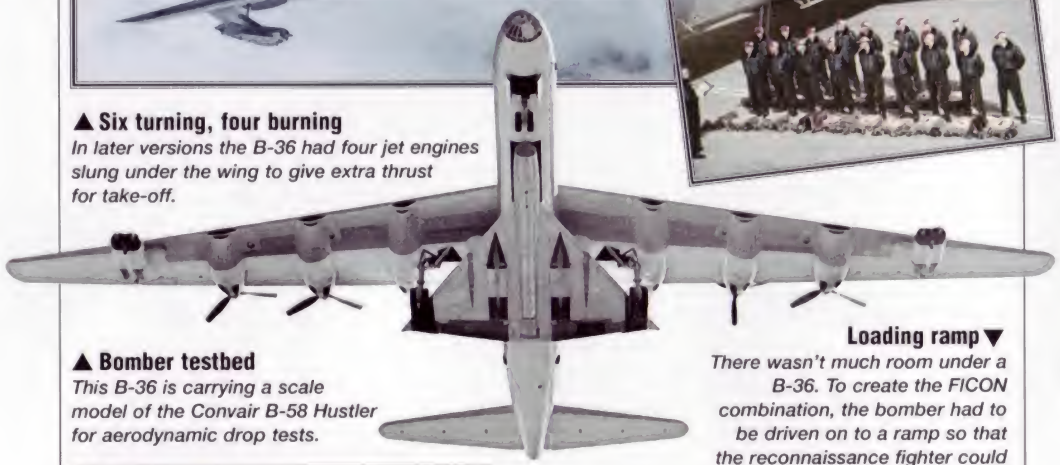
▲ *The B-36 was massive, yet its incredible weight rested on just single mainwheels. These weren't quite the biggest wheels ever carried by an aircraft, but they dwarfed ground crew.*

PHOTO FILE

CONVAIR B-36 FICON

▼ The crew
No fewer than 17 men crawled aboard the 'Big Stick', yet their internal accommodation was capacious.

▲ Six turning, four burning
In later versions the B-36 had four jet engines slung under the wing to give extra thrust for take-off.



▲ Bomber testbed
This B-36 is carrying a scale model of the Convair B-58 Hustler for aerodynamic drop tests.

Loading ramp ▼
There wasn't much room under a B-36. To create the FICON combination, the bomber had to be driven on to a ramp so that the reconnaissance fighter could be squeezed underneath.

▲ Wingtip fighter
Before the FICON project, the USAF tested the B-36 with F-84 fighters towed from the wingtips using this strange attachment.

FACTS AND FIGURES

- A few B-36s were modified to carry a fighter in the bomb-bay.
- Convair developed a huge airlifter from the B-36, the experimental XC-99, but the giant transport never entered service.
- The B-36's radar and communications systems used 3000 vacuum tubes.
- To the men who flew it, the B-36 never had a name. The appropriate nickname 'Peacemaker' was assigned to this mammoth bomber years after it went out of service.
- B-36 missions lasted for so long that it was said to be equipped with a calender rather than clocks.

PROFILE

A deadly combination

Originally designed to drop bombs on Germany from bases in America, the big B-36 began as a six-engined bomber but soon had four jets added, making it a 10-engine behemoth by the time it entered service in 1948. It was tasked to rip out the heart of the Soviet Union with a retaliatory attack, using hydrogen bombs like the Mk 17, which weighed more than a DC-3 transport and was the largest bomb ever deployed by the US military.

When the B-36 flew overhead, it blotted out the sun. In slang, it was called the 'aluminum overcast'. The bomber was so long that crewmen used a powered dolly to transport themselves through the middle of the aircraft between nose and tail.

At high altitude, the vast wings of the B-36 clawed so much air that the bomber was more manoeuvrable than jet fighters. Missions in this incredible giant lasted as long as 40 hours. No other American bomber ever approached the B-36's size, weight, and bomb-carrying capacity.

The NB-36H carried a nuclear reactor to test its effect on the aircraft. The next step would have been a nuclear-powered bomber.

B-36D Peacemaker

Type: intercontinental strategic bomber

Powerplant: six 2834-kW (3800-hp) Pratt & Whitney R-4360-53 radial piston engines and four 23.13-kN (5204-lb-thrust) General Electric J47-GE-19 turbojets

Maximum speed: 700 km/h (435 mph) at 11,000 m (36,000 ft)

Range: 10,944 km (6800 miles) with a 4500-kg (9921-lb) bombload

Service ceiling: 14,780 m (48,490 ft)

Weights: empty 77,581 kg (171,037 lb); loaded 185,976 kg (410,007 lb)

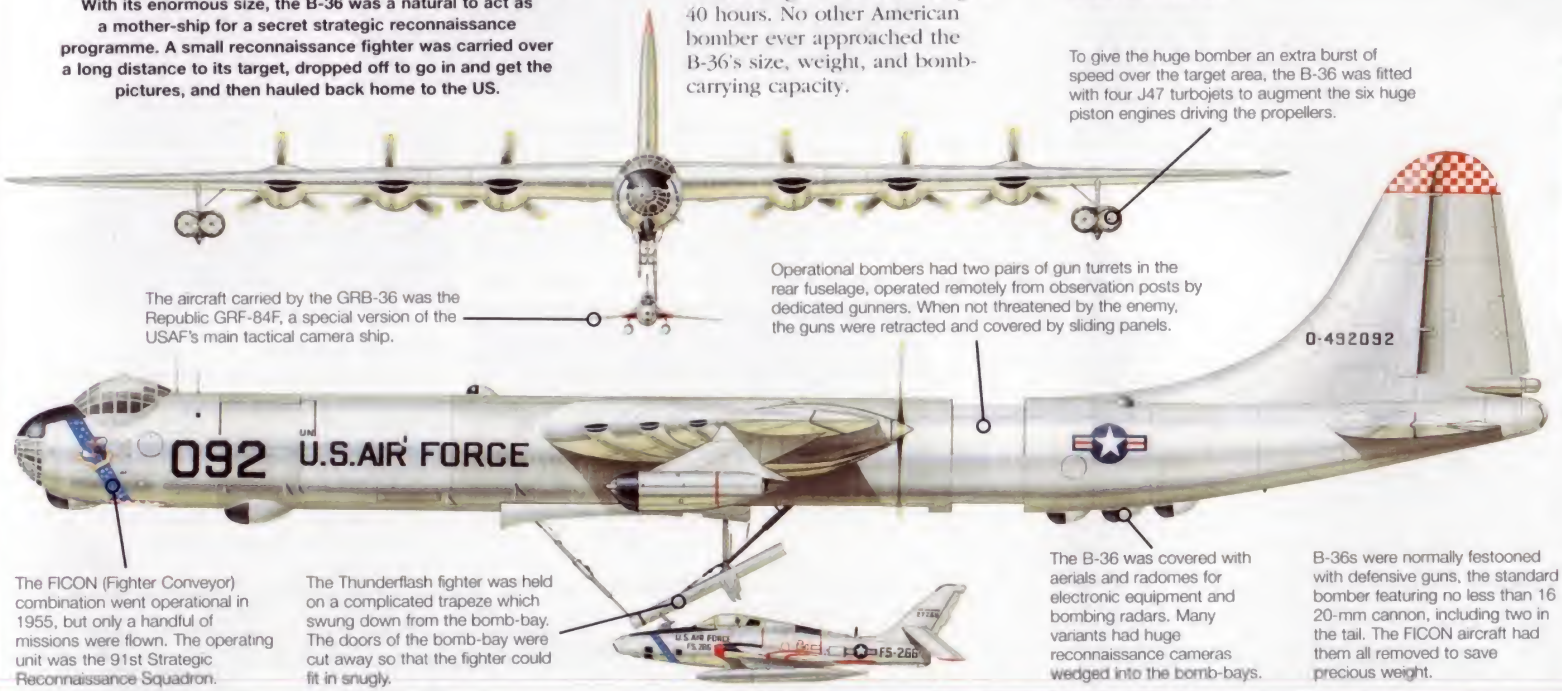
Armament: 16 20-mm cannon in nose, tail and six fuselage turrets, plus bombload of up to 39,000 kg (85,980 lb)

Dimensions:

span	70.10 m (230 ft)
length	49.40 m (162 ft 1 in)
height	14.22 m (46 ft 8 in)
wing area	443.32 m² (4772 sq ft)

GRB-36 FICON

With its enormous size, the B-36 was a natural to act as a mother-ship for a secret strategic reconnaissance programme. A small reconnaissance fighter was carried over a long distance to its target, dropped off to go in and get the pictures, and then hauled back home to the US.



To give the huge bomber an extra burst of speed over the target area, the B-36 was fitted with four J47 turbojets to augment the six huge piston engines driving the propellers.

The aircraft carried by the GRB-36 was the Republic GRF-84F, a special version of the USAF's main tactical camera ship.

Operational bombers had two pairs of gun turrets in the rear fuselage, operated remotely from observation posts by dedicated gunners. When not threatened by the enemy, the guns were retracted and covered by sliding panels.

The FICON (Fighter Conveyor) combination went operational in 1955, but only a handful of missions were flown. The operating unit was the 91st Strategic Reconnaissance Squadron.

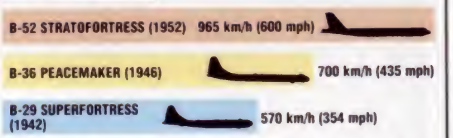
The Thunderflash fighter was held on a complicated trapeze which swung down from the bomb-bay. The doors of the bomb-bay were cut away so that the fighter could fit in snugly.

The B-36 was covered with aerials and radomes for electronic equipment and bombing radars. Many variants had huge reconnaissance cameras wedged into the bomb-bays.

B-36s were normally festooned with defensive guns, the standard bomber featuring no less than 16 20-mm cannon, including two in the tail. The FICON aircraft had them all removed to save precious weight.

COMBAT DATA

MAXIMUM SPEED



Less than a decade spanned the first flights of the Boeing B-29, the Convair B-36 and the Boeing B-52, yet in that time maximum speed almost doubled. All three bombers used their big wings and immense engine power to outperform interceptors at height.

SERVICE CEILING

Bombing from high altitude was seen as the only protection against fighters in the days before guided missiles. The B-36 FICON used another technique – its onboard fighter flew the last, most dangerous part of the mission.

WEIGHTS

The need for massive fuel loads for intercontinental range, and the equally pressing need for huge carrying capacity to deploy the awesome first-generation hydrogen bombs, saw the maximum weights of heavy bombers skyrocket in the decade between the B-29 and the B-52.

Inside the B-36

The B-36 was basically a long tube. The two crew compartments (green) were linked by a crew tunnel with a trolley on rails.

CONVAIR

F-102 DELTA DAGGER

● Supersonic fighter ● Delta-wing pioneer ● Long service career

No spectacle in aviation was more dramatic than the F-102 taking off. Hurtling down the runway and lifting off with its afterburner throwing back a stabbing tongue of fire, the F-102 shattered the eardrums with its deafening roar. Once aloft, the F-102 climbed like a homesick angel, blazing into the stratosphere to intercept enemy bombers and shoot them down.

▲ *With its first attempt at the F-102, seen here, Convair was unable to get the aircraft to fly with anything like the required performance. A radical redesign followed, turning the aircraft into a world-class interceptor.*

PHOTO FILE

CONVAIR F-102 DELTA DAGGER

▲ Pure delta
The wing of the F-102 was almost a perfect triangle, although the wingtip was very slightly cropped. Here a Falcon missile is being fired from the internal weapons bay.

▲ Delta X-plane
To test the delta wing of the F-102, Convair built the XF-92 as a pure research craft. It was a hasty lash-up to get captured German delta-wing technology into the air as fast as possible.

Target drone ▲
Most surviving F-102s were turned into pilotless drones and blown up in missile tests.

▲ Deuce on guard
The F-102 enjoyed a successful career as the USAF's main interceptor in the late 1950s. This aircraft was one which guarded German skies.

▲ Atlantic defenders
The F-102 lasted in service in Iceland until 1973. Much of its time it shadowed Soviet 'Bear' reconnaissance aircraft over the unwelcoming waves of the North Atlantic.

▼ Sad end for a noble warrior
Still wearing the camouflage which it had worn on combat duty in Vietnam, this F-102 is a drone, about to meet its fate in a missile test.

FACTS AND FIGURES

- In all, 990 Convair F-102s were built, including 111 two-seat TF-102As.
- The YF-102 prototype first flew on 24 October 1953.
- The Delta Dagger planned to use nuclear-tipped Falcon air-to-air missiles to stop Soviet bombers.
- The F-102 was one of the first jet aircraft to use onboard computers.
- With its afterburner lit, the Convair was more than 80 times as powerful as a Bf 109 fighter of World War II.
- F-102s went to Turkey and Greece as part of assistance programmes to NATO.

PROFILE

Defender of America's skies

The Convair F-102 was the first supersonic warplane with a delta- or triangle-shaped wing. Designed to defend North America against the bomber attack dreaded by so many during the Cold War, the F-102 combined a 'wasp waist' fuselage shape, technically called 'area rule', with blade-like wings and tail to become one of the fastest fighters of its era.

Although it was a fighter, the F-102 carried no gun. It was armed with an almost unbelievable battery of rockets, including a Falcon missile with an atomic warhead intended to break up bomber formations.

Pilots called this magnificent aircraft the 'Deuce'. It was huge and powerful, and a pleasure to fly. F-102s served briefly in Vietnam where, late in its career, this great plane was miscast in a limited war setting. A few F-102s flew with Greece and Turkey, the only foreign users of one of the best-loved and most memorable aircraft in history and which led to the highly successful F-106 Delta Dart fighter.

Left: Along with its successor, the F-106 Delta Dart, the Delta Dagger was regarded as one of the most beautiful fighters ever built.

Not so beautiful was the TF-102A trainer, which had two seats side-by-side in a cumbersome new front end.

F-102A Delta Dagger

Type: single-seat interceptor

Powerplant: one 49.72-kN (11,183-lb-thrust) Pratt & Whitney J57-P-23 turbojet, increasing to 76.51 kN (17,208 lb thrust) with afterburning

Maximum speed: 1328 km/h (825 mph) at 12,190 m (40,000 ft)

Combat radius: 870 km (541 miles) with full weapons load

Service ceiling: 16,500 m (54,134 ft)

Weights: normal loaded 12,565 kg (27,700 lb); maximum 14,290 kg (31,504 lb)

Armament: three Falcon heat-seeking missiles and one Nuclear Falcon, or three radar and three heat-seeking air-to-air missiles; up to 24 unguided 70-mm (2.75-in) rockets

Dimensions:

span	11.62 m (38 ft 1 in)
length	20.84 m (68 ft 4 in)
height	6.46 m (21 ft 2 in)
wing area	61.45 m² (661 sq ft)

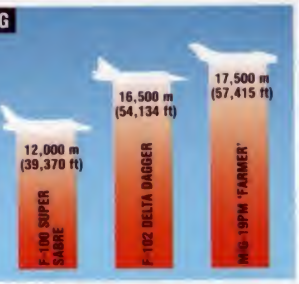
F-102 Delta Dagger

The needle-nosed 'Deuce' was the first interceptor to be developed as part of an overall air defence weapon system, known as WS201A. The F-102 was considered just the airframe portion of this system, to which was added the radar and missile subsystems.

COMBAT DATA

SERVICE CEILING

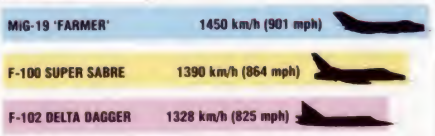
Supersonic fighters were designed with one main aim: to get off the ground quickly, and climb very fast to counter the high-altitude nuclear-armed strategic bomber which was then the pinnacle of air power.



INTERCEPT ARMAMENT

The F-102 was designed as a bomber interceptor, and was possibly the first fighter designed without a gun. Instead, it was armed with Falcon air-to-air missiles, the earliest successful weapons of their type. The MiG-19 could not match the F-102's firepower.

MAXIMUM SPEED



The first generation of supersonic jets were capable of flying at speeds between 1.3 and 1.4 times the speed of sound. Although never achieving the kind of performance which had been expected of it, the delta-winged F-102 was nevertheless in the same league as its contemporaries.

Launching the Falcon

ENCLOSED WEAPONS BAYS: To reduce drag to the barest minimum, the missiles were all carried internally. The capacious bays could hold up to six air-to-air missiles. This fashion has recently been revived with the F-22, albeit to make the aircraft more stealthy.

WEAPONS DEPLOYED: The F-102 had three weapon bays, each holding two Falcons in tandem. Here one of the side bays is opened. Usually three heat-seeking Falcons were carried with three radar-homing missiles.

MISSILE LAUNCH: With the bays open, the missile trapezes were lowered into the airstream to allow the weapon to fire straight off the rail. The doors to the bay would immediately shut.

CONVAIR

B-58 HUSTLER

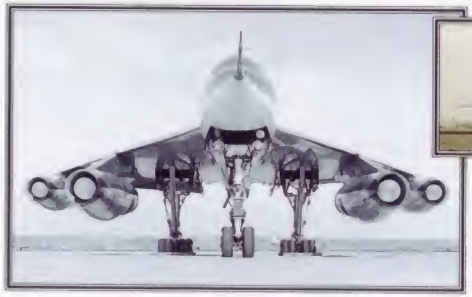
● Supersonic strategic bomber ● Delta wing ● Nuclear-armed

Brilliant but brief – that was the career of the Convair B-58 Hustler of the USAF's Strategic Air Command. From area-rule fuselage through crew escape capsules to its revolutionary J79 engines, everything about the B-58 pushed back the frontiers; it was a towering engineering achievement. Had it gone into battle, the Mach 2-capable Hustler, with its immense performance and advanced podded weapons, would have been able to penetrate Soviet defences with impunity.

▲ *The B-58 was a technological wonder, with blistering performance. Its operational flexibility was limited, however, to the strategic role by its unusual combined fuel- and weapon-pod concept.*

PHOTO FILE

CONVAIR B-58 HUSTLER



▲ Brake chute

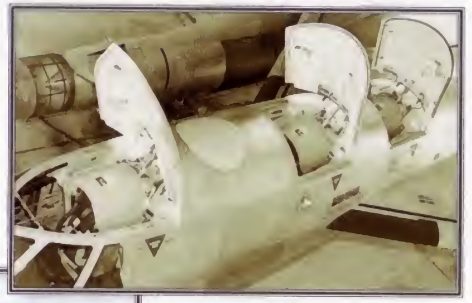
Hustlers landed fast – a typical touchdown speed with a high fuel load remaining was around 350 km/h (217 mph). A braking parachute was often used to prolong the life of the wheelbrakes.

▲ Fast mover

Without its huge fuel and weapon pod the B-58 looked like a fighter, and performed like one, too. With afterburner selected, the Hustler could climb at around 11,500 m (37,730 ft) per minute.

Flying capsules ▶

The three-man crew sat in individual cockpits. They liked their personal escape capsules, but disliked the lack of adequate air-conditioning.



▼ Big delta

The B-58 was the biggest delta ever to enter USAF service and followed Convair's delta fighters, the F-102 and F-106 series.

▲ High altitude

Hustlers performed very well at altitude, and could climb to around 20,000 m (25,610 ft). This enabled them to escape the attentions of most fighters, but the shooting down of the U-2 spyplane in 1960 by a surface-to-air missile showed that high altitude did not guarantee safety.

FACTS AND FIGURES

- The B-58's first flight took place on 11 November 1956, and it became operational in 1960.
- A B-58 carried a five-tonne bombload to a record height of 26,018 m (85,460 ft).
- The Hustler could fly at 1128 km/h (700 mph) at low level, never climbing above 155 m (510 ft).
- The first SAC Hustler wing set 19 world records, including supersonic flights to or from London, Tokyo and Paris.
- Before it could get aloft a fully loaded Hustler had to exceed 400 km/h (250 mph).
- A bear was ejected from a B-58 at 1400 km/h (870 mph) in order to test the escape system.

PROFILE

Twice the speed of sound – in a bomber!

The Convair B-58 Hustler was the world's first supersonic strategic bomber. Designed around the same delta-wing shape used on Convair's highly successful F-102 and F-106 fighters, the Hustler could fly nonstop for 18 hours – carrying a nuclear weapon to any target on the globe. This aircraft was, very simply, the most sensational in its category.

The B-58's four afterburning turbojets could maintain the big bomber at top speed for more than an hour before throttling back. The Hustler's refinements included pilot, bombardier-navigator and systems operator seated in tandem in three cockpits; a two-component droppable weapons/fuel pod under the fuselage that housed any of three weapon systems; and an air-to-surface missile, nuclear bombs or electronic countermeasures gear.

When the advent of the surface-to-air missile brought aerial warfare down to sea level, the high-flying B-58 dropped successfully to low-altitude operations. But one feature stayed up in the stratosphere – its operating costs. The type was retired for economy reasons in 1970 after a decade during which the Hustler equipped two of the USAF's Strategic Air Command bomber wings.

The Hustler had a short operational career, but it must have been a considerable headache for Soviet air-defence planners. It was the most advanced bomber to enter service in the 1960s, as the Myasishchev M-50 and North American XB-70 Valkyrie failed to proceed beyond trials.

Refuelling in the B-58 was much easier than in most aircraft, as the delta wing gave excellent stability and the refuelling port was straight in front of the pilot's canopy.

The J79 turbojet was a mainstay of the inventory in the 1960s; it also powered the F-4 Phantom, the F-104 Starfighter and the US Navy's RA-5 Vigilante.

The B-58 fleet usually had a natural metal finish, as camouflage was not needed for an aircraft that would rarely be seen from above in action.

B-58A HUSTLER

The 116 B-58s equipped two wings of Strategic Air Command, serving from 1960 to 1970, during which time the type set several speed and payload records.

The crew sat in individual cockpits, with the navigator behind the pilot and the defensive systems operator in the rear cockpit.

Four external hardpoints could be fitted with 3200 kg (7,055 lb) of nuclear or conventional bombs.

The huge delta wing had no flaps. Control was provided by elevons – combined elevators and ailerons.

A powerful attack radar system was mounted in the nose. The navigator also had a computerized navigation system.

The rocket-powered BLU-2/B-2 and MB-1C pods contained fuel and weapons. The pod weapons bay could carry five nuclear bombs.

Since B-58 landings were usually fast and hard, the 16 tyres were filled with high-pressure nitrogen.

Chasing a B-58 was a dangerous business because a Vulcan M61 20-mm (0.79-in) cannon was mounted in the tail. This was radar-controlled and remotely operated by the defensive systems operator in the third cockpit.

B-58A Hustler

Type: three-seat supersonic bomber

Powerplant: four 69.39-kN (15,607-lb-thrust) General Electric J79-GE-5B afterburning turbojets

Maximum speed: 1128 km/h (700 mph) at sea level; 2218 km/h (1,376 mph) or Mach 2.1 at high altitude

Range: 8250 km (5,126 miles) on internal and pod fuel

Service ceiling: 17,336 m (56,877 ft) with operational load

Weights: empty 25,202 kg (55,560 lb); take-off 73,937 kg (163,003 lb) (80,250 kg/176,921 lb after inflight refuelling)

Armament: up to 8823 kg (19,450 lb) in underfuselage pod with any six types of nuclear bomb including B43 and B61; one 20-mm (0.79-in) General Electric T-171 (M61A1) tail gun

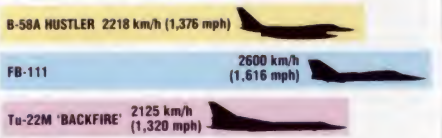
Dimensions:

span	17.32 m (56 ft 10 in)
length	29.49 m (96 ft 9 in)
height	9.58 m (31 ft 5 in)
wing area	143.35 m² (1,543 sq ft)

COMBAT DATA

MAXIMUM SPEED

The B-58 was the fastest bomber of its time, and was quicker than the Soviet 'Backfire' which appeared two decades later. The strategic bomber version of the F-111 fighter which entered service in the late 1960s was faster, but it could maintain its top speed for only a few minutes; the Hustler could keep going at Mach 2 for more than an hour.

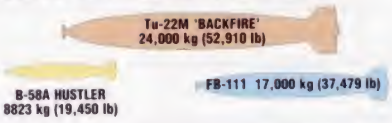


UNREFUELLED RANGE

The B-58 Hustler had superb range for such a powerful machine. It could strike considerably further than the FB-111 which replaced it in the supersonic wings of the USAF Strategic Air Command, and outperformed the 'Backfire' which entered service 10 years after the last B-58 landed for good.

BOMBLOAD

The massive power which ensured great supersonic performance could be used to hoist heavy loads of conventional weapons. The B-58 was never really envisaged as a conventional bomber, however, and lacked the fittings to carry the kind of immense loads the other two bombers could, in theory, manage.



Supersonic strikers

■ **MYASISHCHEV 'BOUNDER':** Roughly contemporary with the Hustler, the Soviet jet was larger but slower, and had limited range.

■ **NORTH AMERICAN XB-70:** First flown in 1964, the XB-70 was a Mach 3 bomber. Astronomical costs meant that it never entered production.

■ **GENERAL DYNAMICS FB-111:** Entering service in 1969, the FB-111 replaced the B-58. It was faster, except when carrying a full load.

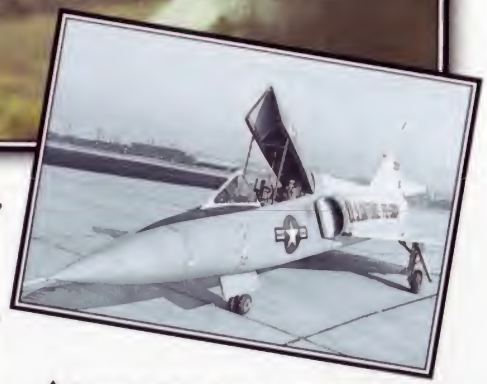
■ **TUPOLEV Tu-22M 'BACKFIRE':** Very similar in performance to the B-58, the swing-wing 'Backfire' became operational 20 years after the Hustler.

■ **ROCKWELL B-1:** The original B-1A prototype could reach Mach 2.5. The B-1B, which entered service in 1985, could fly at only half that speed.

CONVAIR

F-106 DELTA DART

● Interceptor ● Nuclear rocket armed ● Air defender



Though it never fired a shot in combat, the F-106 Delta Dart is one of the most fondly remembered fighters to serve in the US Air Force. Building on experience from its predecessor, the F-102A Delta Dagger, the F-106 carried the flame as the guardian of North America at the Cold War's height. Its job was simple: as an all-weather interceptor it was to detect, identify and destroy Russian bombers carrying atomic weapons to American cities.

▲ *Convair's Delta fighters were extremely capable, complex and costly machines. The Dart was far more useful than the Dagger, which had grave development problems and was never reliable.*

PHOTO FILE

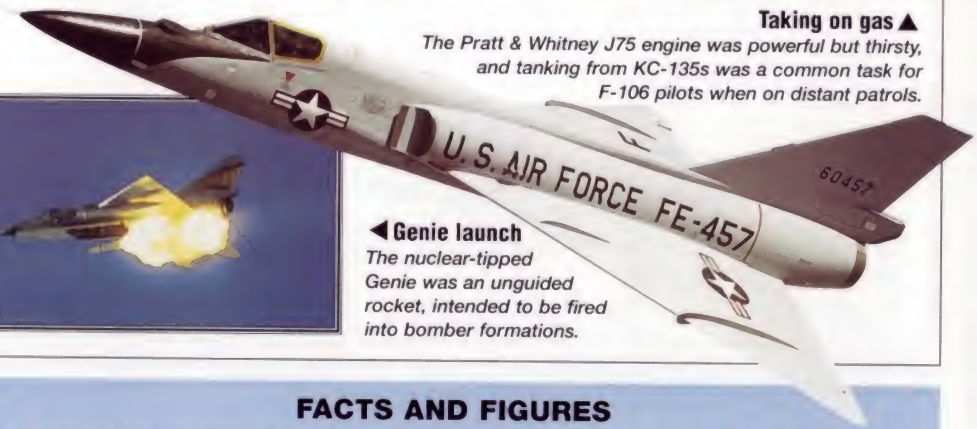
CONVAIR F-106 DELTA DART

▼ Sharp shape
In the quest for all-out speed and climb rate, the F-106 was designed with sharp lines and a thin wing section. Variable air intake geometry was also used.

▲ Red defender
Operating at altitude, with little need for concealment, the F-106 was often painted in bright colours, including orange and red schemes. These colours were designed to make them more conspicuous when operating over polar icefields.

▼ Delta wing
The Delta Dart's only similar feature to the Delta Dagger was its wing. The fuselage had to be considerably revised to cope with the 50 per cent extra thrust of its afterburning J75 engine. The cockpit was moved forward and the tailfin and rudder were redesigned.

Taking on gas ▲
The Pratt & Whitney J75 engine was powerful but thirsty, and tanking from KC-135s was a common task for F-106 pilots when on distant patrols.



◀ Genie launch
The nuclear-tipped Genie was an unguided rocket, intended to be fired into bomber formations.

FACTS AND FIGURES

- The J75 turbojet was chosen after plans to use the Wright J67 Olympus were sidetracked by technical problems.
- The YF-106A prototype made its first flight on 26 December 1956.
- The F-106B had a second crewmember seated behind the pilot.
- In 1961 the last of 277 F-106As and 63 two-seat F-106Bs was delivered to the US Air Force.
- An advanced version with new radar, the F-106C, was only evaluated.
- The final operator was the 177th Fighter Group in Atlantic City in 1987.

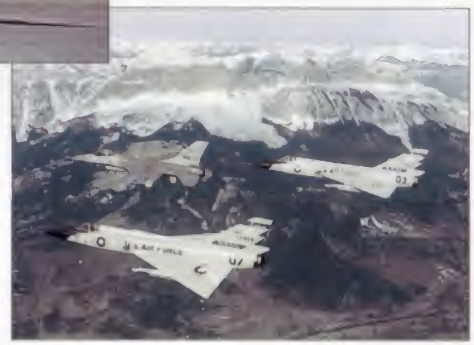
PROFILE

America's delta defender

When it was introduced in the late 1950s, the F-106 was one of the fastest fighters in the world. It had twice the speed of the preceding F-102, and met all requirements of Aerospace Defense Command for a manned interceptor to defend North America. Linked via its complex MA-1 electronic fire-control system through a digital data-link into the nationwide SAGE (semi-automatic ground environment) air defence system, the F-106 was more than the sum of its 'black boxes' and missiles. Improvements to the F-106 included the addition of a gun in a neat installation in the missile bay, causing a slight bulge.

From the time it entered service at Geiger Field, Washington, in 1959, the F-106 was the backbone of North American air defence and was the favourite of many pilots who flew it. The Delta Dart served for much longer than intended and was never actually replaced, despite a continued threat by bombers and cruise missiles. Retirement of the last F-106 by the New Jersey Air National Guard in 1988 marked the end of the F-106 as a fighter. However, 200 airframes have been converted into QF-106 unmanned target drones.

Above: Despite its age, the F-106 remained in the USAF's inventory long after more modern tactical fighters entered service.



Below: Patrols over Alaska were an important task for F-106 crews, as Soviet bombers could have threatened the United States by flying from bases in northeastern Siberia.

F-106A Delta Dart

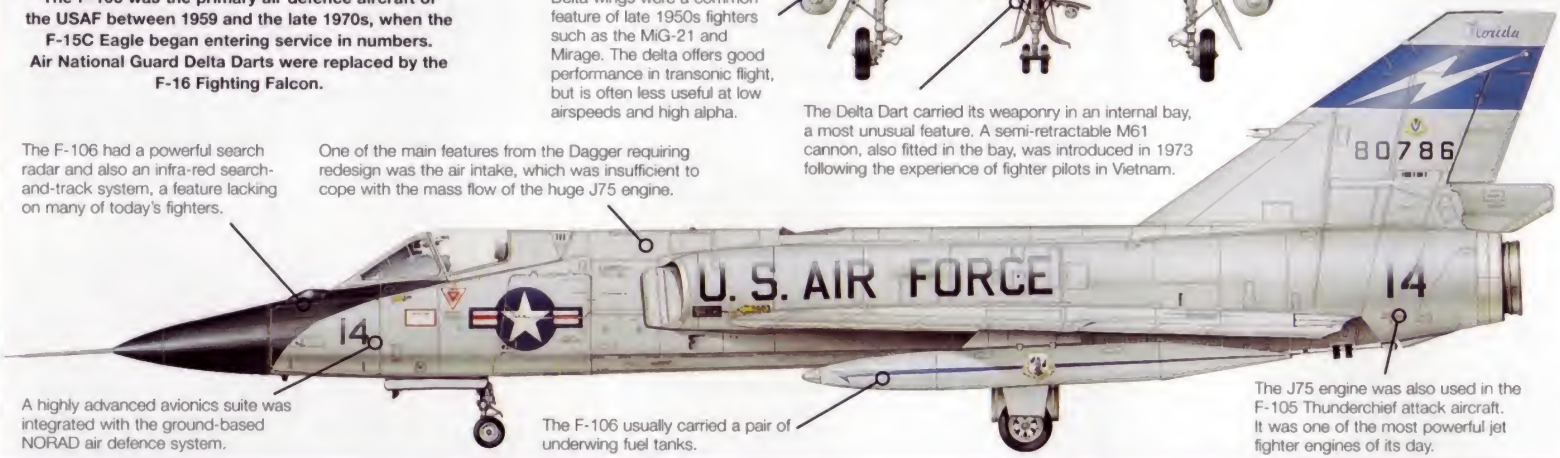
The F-106 was the primary air defence aircraft of the USAF between 1959 and the late 1970s, when the F-15C Eagle began entering service in numbers. Air National Guard Delta Darts were replaced by the F-16 Fighting Falcon.

Delta wings were a common feature of late 1950s fighters such as the MiG-21 and Mirage. The delta offers good performance in transonic flight, but is often less useful at low airspeeds and high alpha.

The Delta Dart carried its weaponry in an internal bay, a most unusual feature. A semi-retractable M61 cannon, also fitted in the bay, was introduced in 1973 following the experience of fighter pilots in Vietnam.

The F-106 had a powerful search radar and also an infra-red search-and-track system, a feature lacking on many of today's fighters.

One of the main features from the Dagger requiring redesign was the air intake, which was insufficient to cope with the mass flow of the huge J75 engine.



A highly advanced avionics suite was integrated with the ground-based NORAD air defence system.

The F-106 usually carried a pair of underwing fuel tanks.

The J75 engine was also used in the F-105 Thunderchief attack aircraft. It was one of the most powerful jet fighter engines of its day.

Air defence of North America

BOMBER ALERT: F-106s are scrambled to catch Soviet bombers out at sea before they can unleash their deadly cruise missiles. The area over the F-106 bases is defended by long-range Hawk and Nike missiles.

MISSILE DEFENCE: Air defence missiles handled most of the threat inshore.

BEAR ATTACK: At high altitude the long-range Tu-95 'Bear' was the main manned aircraft threat to the United States.

FIGHTER CONTROL: The NORAD air defence controller vectors an F-106 towards the incoming bomber. The controller will give the pilot instructions, or the F-106's avionics will automatically compute an intercept solution.

F-106A Delta Dart

Type: single-seat interceptor

Powerplant: one Pratt & Whitney J75-P-17 turbojet rated at 76.5 kN (17,206 lb) dry thrust and 108.99 kN (24,513 lb thrust) with afterburning

Maximum speed: Mach 2.25 or 2400 km/h (1,491 mph) at 12,190 m (40,000 ft)

Range: 1850 km (1,150 miles)

Service ceiling: 17,680 m (58,000 ft)

Weights: empty 10,800 kg (23,810 lb); loaded 16,012 kg (35,300 lb); maximum take-off weight 17,350 kg (38,250 lb)

Armament: one M61A-1 20-mm cannon, four AIM-4E and/or AIM-4G Falcon air-to-air missiles, plus two AIR-2B Genie nuclear rockets

Dimensions:

span	11.67 m (38 ft 3 in)
length	21.55 m (70 ft 8 in)
height	6.18 m (20 ft 3 in)
wing area	697.80 m² (7,511 sq ft)

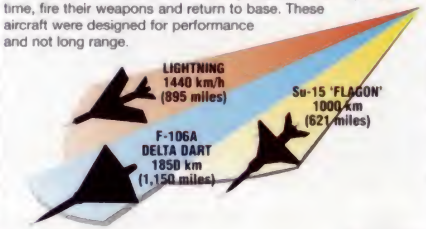
COMBAT DATA

MAXIMUM SPEED

All the interceptors of the 1960s could reach Mach 2 for a short time using afterburner. They could not go far beyond this speed because of kinetic heating causing damage to the alloy airframe.

RANGE

Interceptors are required to reach high altitude in a very short time, fire their weapons and return to base. These aircraft were designed for performance and not long range.



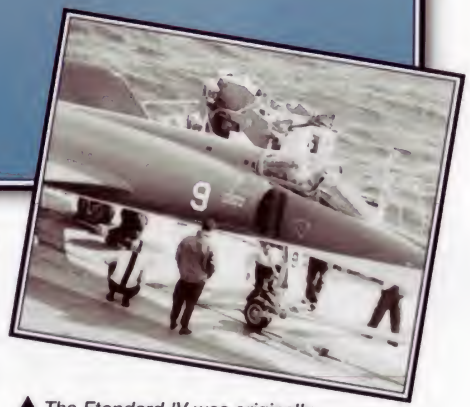
CLIMB RATE

The Lightning and Su-15 'Flagon' could outclimb the heavier Delta Dart, which had more weapons and advanced avionics and carried a great deal more fuel. Most interceptors have to trade fuel load for rate of climb.

DASSAULT BREGUET

ETENDARD IV

● Carrier-based ● Attack and reconnaissance versions ● Long serving



A long with the Etendard VI, which was designed in the mid-1950s as a light-attack aircraft for NATO air forces, Dassault developed a series of aircraft for other roles. After the Fiat G91 was selected to meet the NATO requirement in January 1958, the French navy picked the Etendard IV to equip its two new aircraft carriers. The original Etendard IV was then developed to produce IVM (Marine) attack and IVP photographic reconnaissance versions.

▲ *The Etendard IV was originally intended as a close-support aircraft for the French air force. Instead this versatile machine was developed to become the Aéronavale's carrier attack warplane of the 1960s and 1970s.*

PHOTO FILE

DASSAULT BREGUET ETENDARD IV

▼ IVP reconnaissance version
The IVP's five OMERA cameras (three in the nose and two in a ventral pack) replaced the IVM's attack avionics and guns.

▲ French carriers
Etendards served aboard the French navy's two carriers: the Clémenceau *and the* Foch.

▼ Two-tone grey camouflage
This Etendard IVP of 16F shows the newly applied two-tone camouflage in 1985.

▼ Landing speed
Wing high-lift devices, such as flaps and slats, reduced the Etendard IV's landing speed to 219 km/h (136 mph).

Operational deployment ▶
Entering service in 1962, Etendard IVs supported operations in Djibouti, Lebanon and the former Yugoslavia. This rocket-armed IVM is seen aboard Foch *in 1979.*

FACTS AND FIGURES

- Based on the Etendard, Dassault developed the Super Etendard with radar and more sophisticated weaponry.
- Internal rockets would have been carried by the Etendard IV development.
- Dassault planned tactical reconnaissance, naval and trainer variants.
- While the French air force selected the Mirage III, the navy adopted the larger Etendard IVM.
- Wingspan could be reduced by wing-folding to 7.8 m (25 ft 7 in).
- The highly manouevrable Etendard IVM could enter a loop at only 463 km/h (288 mph).

PROFILE

Locked and loaded for France

Delivered between 1961 and 1965, the 69 Etendard IVMs and 21 IVPs built operated from the aircraft carriers *Foch* and *Clémenceau* until the early 1990s. For attack missions, the IVP could carry an AS-30 missile plus bombs or rockets under each wing. It had an Aïda fire-control radar in the nose, along with an infrared sensor and a guidance antenna for the AS-30.

The IVM was used as an interceptor, too, adding four Sidewinder missiles under the wings. One of the two 30-mm (1.18-in) cannon carried in the belly was usually replaced by Tacan navigation equipment.

In the nose of the IVP were three reconnaissance cameras, and two more were installed in place of the guns in the lower fuselage. It was also equipped for buddy refuelling.

The IVM survived longer in service than the IVP, acting as a tanker for the Super Etendard, which replaced the IVM as well as carrying out reconnaissance missions.

Above: Although the Etendard IVM attack version was long retired, the IVP continued to serve on board Aéronavale carriers until 1996 in the air-to-air refuelling and reconnaissance roles.

Above: This display of weapons carried by the IVM includes AS.20, AS.30 and AIM-9B missiles, 68-mm (2.68-in) SNEB rocket pods and free-fall bombs. The removable ventral gun pack houses two 30-mm (1.18-in) DEFA cannon.

Etendard IVM

Type: single-seat carrier-based attack aircraft

Powerplant: one 43.13-kN (9,700-lb-thrust) SNECMA Atar 88 non-afterburning single-shaft turbojet

Maximum speed: 1096 km/h (681 mph) at sea level

Initial climb rate: 6000 m/min (19,680 fpm)

Combat radius: 298 km (185 miles) (low-level attack); 805 km (500 miles) (medium-level attack profile)

Service ceiling: 15,500 m (50,850 ft)

Weapons: two DEFA 30-mm (1.18-in) cannon; plus up to 1360-kg (3,000-lb) weapon load

Weights: empty equipped 6110 kg (13,470 lb); maximum take-off 10,253 kg (22,605 lb)

Dimensions:

span	9.60 m (31 ft 6 in)
length	14.43 m (47 ft 4 in)
height	4.32 m (14 ft 2 in)
wing area	28.99 m² (312 sq ft)

ETENDARD IVM

This is an IVM of Escadrille de Servitude 59S, based at Hyères on the Mediterranean coast, during October 1981. The unit served as the Etendard carrier training unit and chose as its badge a seagull attempting to land on a swimming turtle.

The IVM's attack avionics comprise a small Aïda radar and a Saab toss-bombing computer. Aïda provided detection and ranging of targets within a small narrow cone directly ahead of the Etendard.

The Etendard IV's small wing makes only a small fold necessary; only the tips fold.

Simple semi-circular lateral intakes feed the Etendard IV's Atar turbojet. A small splitter ramp ahead of each intake removes boundary layer air from the forward fuselage.

Pitch control comes from all-moving tailplanes mounted high up on the vertical fin. Additional control is provided by large elevators inset into the tailplanes.

The pilot sits in an armoured, pressurized cockpit on a French-built Martin-Baker Mk 4 ejection seat. The high seat position gives a good view over the nose on approach to the carrier.

The IVM is fitted with a retractable refuelling probe directly in front of the cockpit. The large vertical blade fairing contains the guidance aerial for the now-obsolete AS.20 radio-guided air-to-surface missile.

The Etendard almost always carried a pair of 600-litre (159-US gal) fuel tanks to boost its relatively poor range. These further reduced the already modest warload.

The Etendard IV has a V-shaped arrestor hook.

ACTION DATA

SPEED

A fast approach to the target and an even more rapid escape are desirable for all-attack aircraft. The Buccaneer has a slight advantage owing to its twin engines.

ETENDARD IVM	1096 km/h (681 mph)
A-4M SKYHAWK II	1100 km/h (683 mph)
BUCCANEER S.Mk 1	1164 km/h (723 mph)

WEAPONS

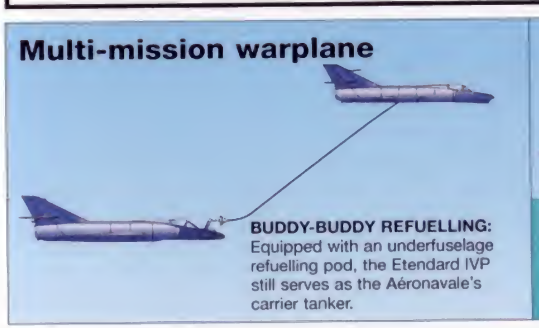
An incredibly large bombload is carried by the unusually small Skyhawk. The Etendard carries the smallest weapon load, but if nuclear devices were used this would be of little consequence.

ETENDARD IV	A-4M SKYHAWK II	BUCCANEER S.Mk 1
1360 kg (3,000 lb)	4145 kg (9,140 lb)	3630 kg (8,000 lb)

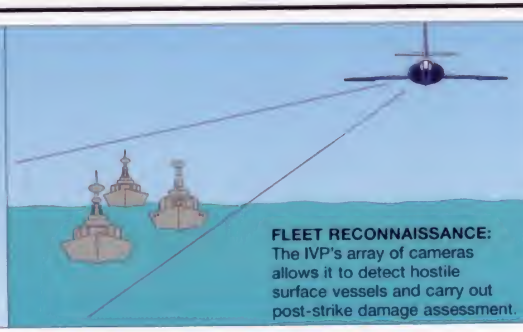
COMBAT RADIUS

Larger aircraft often have longer range. This is true of the Buccaneer, although by modern standards all three types are modest performers in this respect.

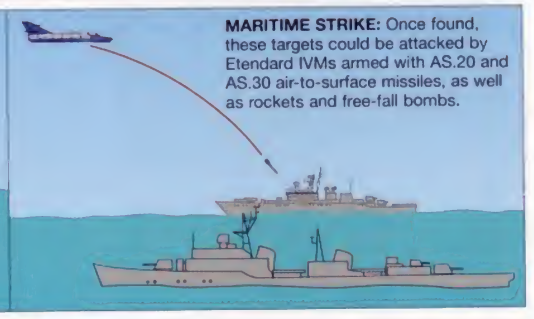
Multi-mission warplane



BUDDY-BUDDY REFUELLING: Equipped with an underfuselage refuelling pod, the Etendard IVP still serves as the Aéronavale's carrier tanker.



FLEET RECONNAISSANCE: The IVP's array of cameras allows it to detect hostile surface vessels and carry out post-strike damage assessment.



MARITIME STRIKE: Once found, these targets could be attacked by Etendard IVMs armed with AS.20 and AS.30 air-to-surface missiles, as well as rockets and free-fall bombs.

DASSAULT-BREGUET

MIRAGE III/5

● Mach 2 delta-wing jet ● Reconnaissance ● Ground-attack fighter

▲ *The Mirage has seen more combat than most jets, with mixed results. In the hands of well-trained pilots, however, it has proved to be a lethal fighting machine, as good as any fighter in the world.*

A shining jewel in the crown of French aircraft design, the Dassault Mirage III is a pioneering supersonic delta-winged jet that cemented the reputation of Dassault as a premier manufacturer of world-class jet fighters. With its perfect blend of speed, sophistication and simplicity, this Mach 2 delta became the backbone of France's air arm in the 1960s and still serves a dozen nations.

PHOTO FILE

DASSAULT-BREGUET MIRAGE III/5

Flying lab ▶
The Milan was an experimental high-agility version of the Mirage III with forward-swept nose-mounted canard foreplanes.

▲ Maritime strike
A number of Pakistan's Mirage 5s have been upgraded to 5PA3 standard featuring the Agave radar for use with Exocet anti-ship missiles.

◀ Eye in the sky
Equipped with nose-mounted cameras, the Mirage IIIR is a superb reconnaissance aircraft. Its high speed and stable handling at low level made it very popular with pilots.

▲ Ground-attack warload
Mirage armament includes MATRA 530 missiles, rockets, cannon and bombs.

▲ Air defender
Australia was one of 20 nations to operate variants of the Mirage III. Sidewinder-armed Mirages served in the air defence role until 1989.

◀ On the road
The Swiss air force is also a user of the Mirage III. Swiss pilots are trained to operate from small mountain airfields or even from straight stretches of highway.

FACTS AND FIGURES

- The prototype Mirage III made its maiden flight on 17 December 1956.
- The Mirage III was one of Western Europe's first Mach 2 fighters.
- The Mirage 5/50 series was conceived as an 'economy' Mirage III with no radar and a modified cockpit.
- Between 1956 and 1992, 1422 Mirage III, 5 and 50 aircraft were manufactured.
- Mirages can deliver a wide variety of air-to-surface weaponry, up to the size of Exocet anti-ship missiles.
- Some Mirage IIIs in Israeli service have notched up at least 10 combat kills.

PROFILE

Dassault's deadliest delta

The Mirage III is the progenitor of a family of interceptors and fighters which have in common an instantly identifiable delta wing and an almost incredible capability to fly and fight. This creation of Avions Marcel Dassault is also one of the most beautiful aircraft ever to take to the skies, and never fails to turn heads whenever it appears.

At least three-dozen versions of the Mirage III family have appeared since its first flight nearly four decades ago, including two-seat models and aircraft intended for strike/attack and reconnaissance in addition to the primary job of air-to-air combat. The Mirage IIIE strike fighter was a component of France's independent nuclear force until 1988.

Mirages have fought in many wars, most famously with the Israeli forces in 1967 when the aircraft shot down large numbers of MiG-21s. Twenty nations have operated Mirage IIIs as well as its Mirage 5 and 50 variants. Many are still flying, having been upgraded and improved to remain highly effective combat aircraft even in the type's fifth decade.

Celebrating the unit's seventieth anniversary, this Mirage 5 of No. 2 Squadron, Belgian air force, sports a vivid colour scheme. Belgium retired its Mirage force in 1993.

A special badge and paint scheme for a French air force Mirage, celebrating the Republic's bicentenary.

The Mirage's delta wing means that it has no conventional tailplane. Roll and pitch are controlled by the 'elevons' – combined elevators and ailerons – on the wing trailing edge.

Mirage IIICJ

The Mirage III really made its name in 1967, when the Israeli air force gained a stunning victory over Arab forces. Mirage pilots became the highest-scoring jet aces since the Korean War.

A British Martin-Baker ejection seat is fitted to most Mirages, although some use American-designed seats.

Israeli Mirages originally used the French Atar turbojet, but when Israel built its own Mirages it fitted the more powerful American J-79 engine, as fitted to the F-4 Phantom.

Pilot visibility ahead and to the side is good, although the rear view is limited especially when compared with more recent fighters such as the F-16 and MiG-29.

Early Mirages had fairly primitive radar sets giving range information only. Most have been upgraded with multi-mode systems such as the Israeli Elta series.

Mirage IIIs carry a pair of DEFA 30-mm (1.18-in) cannon beneath the intakes. These are potent weapons in dogfights and ground-attack missions.

In the air-combat role, Israeli Mirages usually carried two drop-tanks and two Sidewinder or Python missiles as well as two 30-mm (1.18-in) cannon.

Mirage IIIE

Type: single-seat fighter

Powerplant: one SNECMA 41.97-kN (9,440-lb-thrust) Atar 9C-3 (60.80 kN/13,674-lb-thrust with afterburning) and provision for one jettisonable 14.71-kN (3,308-lb-thrust) SEPR 844 rocket booster

Maximum speed: 2350 km/h (1,460 mph) or Mach 2.1

Range: 2400 km (1,491 miles)

Service ceiling: 14,440 m (47,375 ft)

Weights: empty 7050 kg (15,543 lb); loaded 13,700 kg (30,203 lb)

Armament: 30-mm (1.18-in) DEFA 552 cannon with 125 rounds; Nord 5103, MATRA R.511, MATRA T.53 or Hughes AIM-26 Falcon missiles

Dimensions:

span	8.22 m (27 ft)
length	15.03 m (49 ft 4 in)
height	4.50 m (14 ft 9 in)
wing area	35.00 m² (377 sq ft)

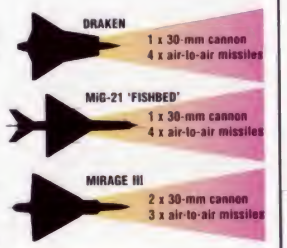
COMBAT DATA

MAXIMUM SPEED

The Mirage III was one of the earliest of the Mach 2-capable jets which first appeared in the mid- to late 1950s. Even today, nearly 40 years later, it is one of the world's best high-speed performers at altitude.

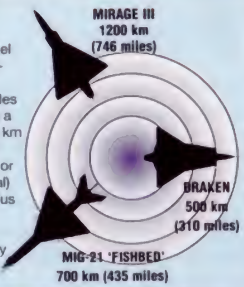
ARMAMENT

The appearance of the Mach 2 fighter coincided with the development of effective air-to-air missiles. The Mirage carried fewer weapons than some of its contemporaries, but unlike its rivals was capable of engaging beyond visual range with a single medium-range radar-guided Nord 5103 or MATRA R.511 missile.

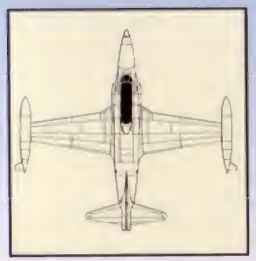


INTERCEPT RADIUS

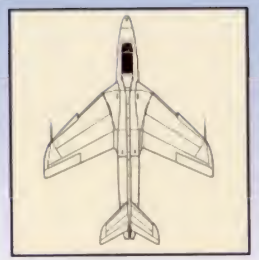
Mirage III carries more than 2900 litres (766 US gal) of fuel internally. Two external drop-tanks of up to 1700 litres (500 US gal) more than doubles the load, giving the Mirage III a ferry range in excess of 4000 km (2485 miles). A more normal underwing load of two 625- or 1100-litre (165- or 290-US gal) tanks gives an operating radius of more than 1000 km (620 miles) on intercept missions. This is considerably better than most of the Mirage's contemporaries.



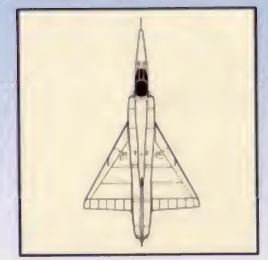
The delta wing advantage



STRAIGHT WING: From the earliest days of flight, aircraft wings have generally been straight. This provides maximum lift at low speeds. With the advent of the jet engine, however, aircraft began to have the power to push much closer to the speed of sound, and straight-winged machines began to encounter problems with compression and drag.



SWEPT WING: Pioneering work in the 1940s showed that sweeping the wing back enabled an aircraft to travel much faster, delaying the compression of the fast-moving air which causes turbulence and increases drag immensely. By making the wings much thinner and sweeping back even further, fighters were able to penetrate the 'sound barrier'.



DELTA WING: German aviation pioneer Alexander Lippisch discovered in the 1930s that a triangular wing, looking like the Greek letter delta, could be made much thinner in cross-section. This offered significant advantages at supersonic speeds and high altitudes. The disadvantage was in landing, where deltas come in very fast and with a nose-high attitude.

DASSAULT-BREGUET

MIRAGE IV

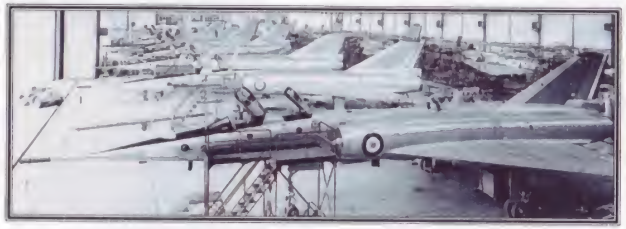
● Supersonic nuclear bomber ● Strategic reconnaissance platform

France's Mirage IV was the aerial component of its 'Force de Frappe', or nuclear deterrent. A delta-winged aircraft based on the well-proven Mirage III design, but very much enlarged, the Mirage IV was flown by a crew of two, with pilot and navigator sitting in tandem cockpits. This supersonic striker was designed for one job – to carry an atomic weapon to Russia, possibly on a one-way trip.

▲ *The Mirage IV remaineed a potent long-range strike aircraft for more than 35 years, thanks to its performance, allied with effective upgrades and the ability to carry advanced new weapons.*

PHOTO FILE

DASSAULT-BREGUET MIRAGE IV



▲ Production line ▼

The Mirage IVA production line delivered aircraft between December 1963 and November 1966. By that year, a force of nine squadrons was operational, each with four aircraft on alert status (below).

▲ Big brother

The Mirage IV dwarfed the rest of the Mirage family. It was three times as heavy as these early Mirages and twice as heavy as the latest two-seat nuclear strike Mirage, the 2000N.

Stand-off attack ▶

The Air-Sol-Moyen-Portée (ASMP) missile became the Mirage IV's primary weapon. With a range of over 250 km (155 miles), it allowed the Mirage to strike from a distance.

▲ Rocket launch

The Mirage IV needed a fairly long runway to take off. To assist on short airstrips, the big delta could be fitted with rocket-assisted take-off packs.

◀ Silver machine

The polished metal of the original Mirage IV was a sign of the high-level delivery profile used in the 1960s. Like most bombers of the era, when its mission profile went down to low level a striped camouflage scheme was applied.

FACTS AND FIGURES

- The Mirage IV was expected to fly supersonic at low level only on its final run-in to the target.
- The ASMP stand-off missile was armed with a 300-kiloton TN81 warhead.
- A few radar-equipped Mirage IVs were assigned to reconnaissance duties.
- The Mirage IV could operate from a short runway, boosted into the air by six rockets under each wing.
- Production of the Mirage IV was completed in March 1968.
- EB 1/91 'Gascogne' and EB 2/91 'Bretagne' were the last Mirage IV units. The strike variant was retired in 1996.

PROFILE

France's supersonic nuclear bomber

The Mirage IV was a Mirage III scaled up by a factor of approximately two to become a strategic nuclear bomber. It was an aircraft which was designed to fly so fast and so high that it could not be successfully intercepted by any fighter. Even now, decades after its first flight on 17 June 1959, the aircraft's performance is scarcely matched.

The Mirage IV became operational in 1964, when four squadrons totalling 62 aircraft enabled President de Gaulle to declare France separate from NATO and independent in world affairs.

The Mirage's original warload consisted of a 60-kiloton yield AN-22 free-fall nuclear bomb semi-recessed into the underside of the fuselage. When the Mirage was switched to low-level missions in the late 1960s, the AN-22 was fitted with a parachute retardation system.

Four aircraft were adapted for strategic reconnaissance, with a CT 52 reconnaissance pod fitting into the belly recess. The pod was usually equipped with six cameras and a mapping camera. An infra-red linescan camera could also be fitted for low-level all-weather missions.

Although clearly a great warplane, the Mirage IV never had the range to make a comfortable round trip to Russian targets, and pilots accepted that their missions might be one-way. Silo-based missiles have taken over the job of nuclear readiness, and the Mirage IV has now been retired, with the last reconnaissance variants being struck off the inventory in 2005.

The Mirage IV was a survivor from an era when delta-winged bombers were the cutting edge of major air forces. The Mirage was smaller than the Vulcan, B-58 and Myasishchev delta designs of the period, but was a good solution to the limited needs of the Force de Frappe.

Mirage IVA

Type: two-seat long-range bomber

Powerplant: two SNECMA Atar 9K-50 engines each rated at 70.61 kN (15,880 lb thrust) with afterburning

Maximum speed: Mach 2.20 or 2338 km/h (1,453 mph) 'clean' at 11,000 m (36,090 ft); 1350 km/h (839 mph) at sea level

Range: 4000 km (2,485 miles)

Service ceiling: 20,000 m (65,617 ft)

Weights: empty 14,500 kg (31,967 lb); loaded 31,600 kg (69,666 lb)

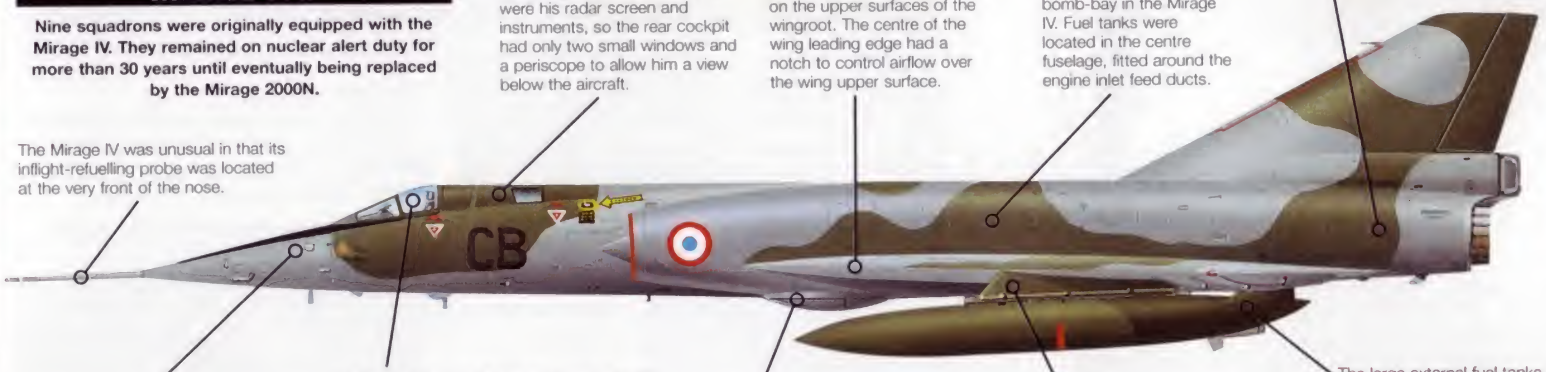
Armament: ASMP nuclear missile or six conventional bombs or four AS.37 Martel anti-radar missiles or one CT 52 sensor pod

Dimensions:

span	11.85 m (38 ft 11 in)
length	23.50 m (77 ft 1 in))
height	5.65 m (18 ft 6 in)
wing area	78.00 m² (840 sq ft)

Mirage IVP

Nine squadrons were originally equipped with the Mirage IV. They remained on nuclear alert duty for more than 30 years until eventually being replaced by the Mirage 2000N.



The twin Atar engines gave the Mirage IV twice as much power as most other Mirage variants. A brakechute was stored in the housing above the jetpipes.

The navigator's main references were his radar screen and instruments, so the rear cockpit had only two small windows and a periscope to allow him a view below the aircraft.

Large airbrakes were mounted on the upper surfaces of the wingroot. The centre of the wing leading edge had a notch to control airflow over the wing upper surface.

There was no internal bomb-bay in the Mirage IV. Fuel tanks were located in the centre fuselage, fitted around the engine inlet feed ducts.

The Mirage IV was unusual in that its inflight-refuelling probe was located at the very front of the nose.

A retractable spotlight was fitted to allow the crew to carry out night inflight-refuelling. An OMERA camera is located just ahead of it for post-strike damage assessment.

Both pilot and navigator were provided with Hispano-built Martin Baker BM.4 ejection seats. The pilot's cockpit had a two-panel 'knife edge' windscreen, reminiscent of American Convair fighter designs.

Unusually for a low-level strike aircraft, the Mirage IV had its radar mounted in the belly, not the nose. The navigator operated the Thomson-CSF Cerval radar warning system.

All Mirage IV weaponry was located on the external centre pylon. Jamming pods could be carried on wing outboard pylons.

The large external fuel tanks, which could each hold 2500 litres (660 US gal) of fuel, could be retained at supersonic speeds.

France's nuclear triad

▼ SEA-BASED DETERRENT: France has six nuclear-powered ballistic missile submarines. The least accurate component of the triad, the underwater launch platforms are also the most secure.

◀ M-4 MISSILE: Roughly equivalent to the American Poseidon, the M-4 has a range of between 4500 and 6000 km (2,800 and 3,730 miles).

◀ S-3 MISSILE: Carrying a 1.2-megaton warhead and with a range of 3500 km (2,175 miles), the S-3 is the most powerful component of the triad.

▶ ASMP: The Air-Sol-Moyen-Portée missile is a supersonic ramjet with a range of up to 250 km (155 miles) carrying a 300-kiloton warhead.

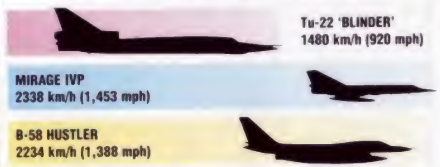
▲ LAND-BASED DETERRENT: Eighteen land-based missiles are very accurate, but are vulnerable to enemy action.

▲ AIRBORNE DETERRENT: Two squadrons of Mirage IVPs formed the smallest but most flexible portion of the deterrent triad.

COMBAT DATA

MAXIMUM SPEED

The Mirage IV is very fast and can climb very high. Its only rival in the 1960s was the slightly earlier Convair B-58 Hustler, which was marginally slower. The American jet was much more powerful, however, and could carry a heavier bombload at supersonic speeds for much longer periods. The contemporary Soviet Tupolev was much slower, but could also carry more weapons.

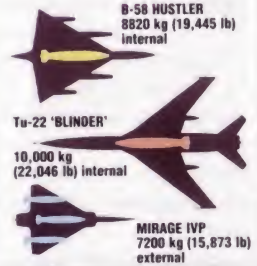


COMBAT RADIUS

The Mirage's major weakness was always its marginal range. Even with its internal and external fuel tanks, the prospect of making a successful mission deep into Soviet territory was slim at best. Aerial refuelling is essential for successful Mirage operations.

WEAPONS LOAD

Although the Mirage IV can lift a fair weight of bombs, its normal nuclear load of one 60-kiloton weapon was not very large by comparison with the multi-megaton yields carried by the Hustler and 'Blinder'. The adoption of the ASMP missile with its larger warhead means that, even though the Mirage IVP is close to retirement, it is still a potent delivery system.



DASSAULT-BREGUET

MIRAGE F1

● Air defence ● Ground attack ● Reconnaissance

France's Dassault Mirage F1 comes from a company with decades of experience in designing affordable high-performance jet fighters. When the first F1 flew on 20 March 1969, it immediately demonstrated improvements over its predecessor, the delta-wing Mirage III. The F1 introduced more fuel economy, better avionics and increased agility. Although now an ageing design, the F1 will remain a viable frontline aircraft well into the twenty-first century.

▲ *Following the extremely popular Mirage III on Dassault's production lines, the Mirage F1 was a great advance on the pioneering delta-wing fighter, and it also achieved export success.*

PHOTO FILE

DASSAULT-BREGUET MIRAGE F1

◀ Spy in the sky

The Mirage F1CR is France's primary tactical reconnaissance aircraft. It can carry a variety of radar, infrared and optical sensors.

▼ Global reach

The F1C-200 has a fixed refuelling probe, which with the support of Boeing C-135FR tankers enables the interceptor to deploy almost anywhere in Africa or the Middle East.

▼ Reliable power

The Atar turbojet has been continually developed over more than four decades. The version in the F1 needs servicing every 300 hours, with a full overhaul being required after 900 hours of use.

▼ French defender

The Mirage F1 was France's main air defence interceptor for more than 15 years, from the middle of the 1970s until it was replaced in the role by the more advanced Mirage 2000.

◀ Mirage with a tail

The conventional wing and tailplane layout of the F1 was a temporary break in Dassault's delta-wing tradition.

FACTS AND FIGURES

- Most F1s use Cyrano IV air-to-air radar to detect intruders and aid in engaging enemy warplanes.
- In France, the F1 replaced the SNCASO Vautour IIN all-weather interceptor.
- The reconnaissance Mirage F1CR first flew on 20 November 1981.
- Users of the F1 have included Ecuador, Iraq, Jordan, Kuwait, Qatar, Libya, Morocco, South Africa and Spain.
- At least one Angolan MiG was shot down by a South African Mirage F1.
- In the Gulf War, an Iraqi F1 flew into the ground while chasing an EF-111A Raven.

PROFILE

Dassault's gallic guardian

Mirage is the beautiful and evocative word chosen by Avions Marcel Dassault (which became Dassault-Breguet) as the name for its modern jet combat planes. The classic Mirage of the 1970s, which has given superb service for more than two decades, is the Mirage F1.

Battle tested, the Mirage F1 has been a bastion of France's air defence capability for many years. Equally successful as a ground-attack and a reconnaissance airplane, it is respected by its allies and feared by its enemies.

The first of more than 220 aircraft for the French air force were ordered in 1969, with the initial production fighter being delivered on 14 May 1973. The first operational unit was 30 Escadre de Chasse, which converted to the type on December of that year.

It has also been a great success in the export market, having been sold to 10 air forces. South African F1As were adapted as strike aircraft with secondary air-to-air duties. It was used by both sides during the Gulf War, although eight of Iraq's Mirage F1EQ fighters were downed by American and Saudi F-15 Eagles.

Primary armament of the original Mirage F1 was a single Matra 530 missile with two Matra R.550 Magic dogfight missiles on wingtip rails.

The F1's cockpit is reasonably roomy by the standards of its time, but it lacks the all-round visibility now common.

The instrument panel is old-fashioned, with small analog instruments and a shielded radar scope.

The Mirage's high-lift wing gives much better low-speed agility than the previous delta form, while maintaining excellent high-speed and high-altitude performance.

Mirage F1CE

Spain was one of the first export users of the F1, ordering 15 F1CE interceptors in 1972. All of Spain's 73 Mirages are assigned to the Ala de Caza (Fighter Wing) 14.

Fighters and multi-role variants of the Mirage F1 carry pitot probes on the tips of their nose radomes. These gather data from the clean airflow ahead of the aircraft for the aircraft's primary flight instruments, including the airspeed indicator and altimeter.

The Mirage F1 has semi-circular air intakes with a variable shock cone centre body, which regulates air flow to the engine at supersonic speeds. The fighter's two 30-mm (1.18-in) cannon are housed in the lower intake trunking.

Like most aircraft of its generation, the Mirage F1 is of all-metal monocoque construction, with no significant use of advanced alloys or composite materials.

The distinctively long and slender Mirage radome covers the antenna of its Cyrano radar. This is a multi-function system capable of air-to-air and air-to-ground operation.

Many NATO squadrons with big cats in their squadron badges take part in multinational exercises known as 'Tiger Meets'. Aircraft such as this Ala 14 machine participating in these events often receive temporary 'Tiger stripe' decoration.

Mirage F1C

Powerplant: One 70.43-kN (15,840-lb-thrust) SNECM Atar 9k-5 afterburning turbojet

Max speed: 2334 km/h (1,450 mph) or Mach 2.2 at high altitude

Initial climb rate: 12,777 m/min (41,918 fpm)

Ceiling: 20,000 m (65,600 ft)

Range: 2594 km (1,612 miles) with drop tanks and light combat load

Weights: empty 7384 kg (16,280 lb); maximum 15,168 kg (33,440 lb)

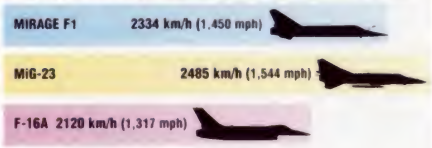
Weapons: two 30-mm (1.18-in) DEFA 553 cannon with 270 rounds; two Matra Super 530 radar missiles and/or two Matra R.550 Magic infrared missiles; up to 3622 kg (7,986 lb) of ordnance

Dimensions:		
	span	8.23 m (27 ft)
	length	14.94 m (49 ft)
	height	4.57 m (15 ft)
	wing area	24.99 m² (269 sq ft)

ACTION DATA

SPEED

The Mirage F1 is no slouch, being capable of reaching Mach 2.2 at altitude. The contemporary MiG-23 is much more powerful and has a slight advantage, while the agile American F-16 is slower.



SERVICE CEILING

Although it has excellent low-level performance, the Mirage F1 really excels at high altitude. Its service ceiling is better than most other fighters, and is outclassed only by immensely powerful machines such as the MiG-25 'Foxbat'.

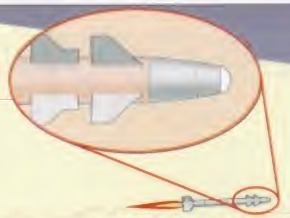
AIR-TO-AIR WEAPONS

Most modern fighters carry a range of weapons. Larger missiles can destroy enemy aircraft at well beyond visual range, while smaller, more agile weapons are used in dogfights.

Matra Magic in action

SHORT-RANGE ENGAGEMENT: The F1's main close-combat weapon is the Matra R.550 Magic missile, which has a range of up to 5 km (3 miles).

HEAT SEEKER: Magic is guided by detecting and homing in on infra-red radiation, or heat. Once the missile has detected and locked onto a target, it is ready to be launched.



HOMING IN: A highly sensitive infra-red detector mounted on gimbals in the missile's nose automatically points towards the source of heat. Control fins are slaved to the seeker, automatically steering the weapon towards the target.

HEAT SOURCE: All aircraft generate heat. The most obvious source is from the jet exhaust, which acts as a beacon to heat-seeking missiles.

IN FOR THE KILL: A proximity fuse detonates the 13-kg (29-lb) high-explosive/fragmentation warhead when within lethal range.

DASSAULT-BREGUET

ATLANTIC

● Anti-submarine ● Anti-ship ● Maritime patrol aircraft

▲ *Comprehensive systems upgrades have kept the Atlantic in service and it is still a very effective maritime aircraft. Fewer than 100 were built, but survivors remain flying in the arduous, low-level marine environment.*

A NATO requirement of the late 1950s for a long-range maritime reconnaissance aircraft was met by Breguet with the Br.1150 Atlantic. The European consortium which was formed to build it included several companies whose names have been consigned to aviation history, such as Aeritalia, Breguet and MBB. But the Atlantic, refurbished and modernized, soldiers on and will continue to patrol the seas well into the twenty-first century.

PHOTO FILE

DASSAULT-BREGUET ATLANTIC

Martel missiles ▶
Anglo-French AS.37 Martel guided missiles, carried on the underwing pylons, give the Atlantic an effective anti-surface vessel capability.

▲ Long-term Italian service
Italy received 18 Atlantics, with deliveries commencing in June 1972. They have been upgraded with Atlantique and Nimrod systems.

▲ Low-visibility
In the current trend, this Italian aircraft is finished in a low-visibility colour scheme. It also carries a non-standard spine antenna.

▼ Valkenburg's Atlantics
No. 321 Squadron of the Royal Netherlands Navy received nine Atlantics, which were based at Valkenburg. The aircraft have now been retired.

▲ Atlantic configuration
The aircraft's spine fairing, MAD boom and fin-mounted radome are clearly visible on this Aéronavale Atlantic.

FACTS AND FIGURES

- Breguet beat 24 designs from manufacturers in nine countries to win the NATO maritime patrol competition.
- Italy did not join the constructors' consortium until 1968.
- An international consortium was also established to build the Tyne engines.
- Some reports suggest that the Atlantic can deliver nuclear depth charges, each with a yield of 40 kilotons.
- Improvements to German Atlantics have extended their life to 10,000 hours.
- Three aircraft sold to Pakistan in 1975 continue to serve with No. 29 Squadron.

PROFILE

Venerable ocean patroller

Breguet flew the Atlantic for the first time from its Toulouse factory in October 1961. A successor to the Lockheed P-2 Neptune which was in European service, it was equipped with similar anti-submarine warfare systems, although it had a French radar, American sonar equipment and British-designed turboprop engines. The fuselage contains an unpressurized lower section in which the weapons are carried, and a magnetic anomaly detector (MAD) for sensing the presence of submarines is situated in the tailboom.

Several of the 40 Atlantics built for the French navy remain in service at colonial bases, although most are being replaced by the second-generation Atlantique 2. Three of the French navy's aircraft were supplied to Pakistan in the mid-1970s.

Six of the 20 Atlantics acquired by Germany were modified for electronic reconnaissance, and the rest have been updated with new radar, sonar and electronic warfare equipment.

Italy's 18 Atlantics were the last to be delivered. Supplied from 1972 to 1974, they were upgraded between 1988 and 1992 with systems designed for the Atlantique. The Netherlands navy chose to replace its six remaining aircraft of the nine originally supplied with Lockheed P-3C Orions.

Above: One of Germany's Atlantics shows its retracted radar radome and sonobuoy launch tubes.

Below: Most Atlantics, including this Italian aircraft, have spent their entire careers in this dark-grey over white colour scheme. Italian machines are used to patrol the Mediterranean.

Atlantic 1

Type: maritime reconnaissance and anti-submarine aircraft

Powerplant: two 4549-kW (6,100-hp) Rolls-Royce Tyne RTy20.Mk 21 turboprops

Maximum speed: 658 km/h (409 mph)

Endurance: 18 hours

Service ceiling: 10,000 m (32,808 ft)

Weights: empty 25,000 kg (55,116 lb); maximum take-off 44,500 kg (98,106 lb)

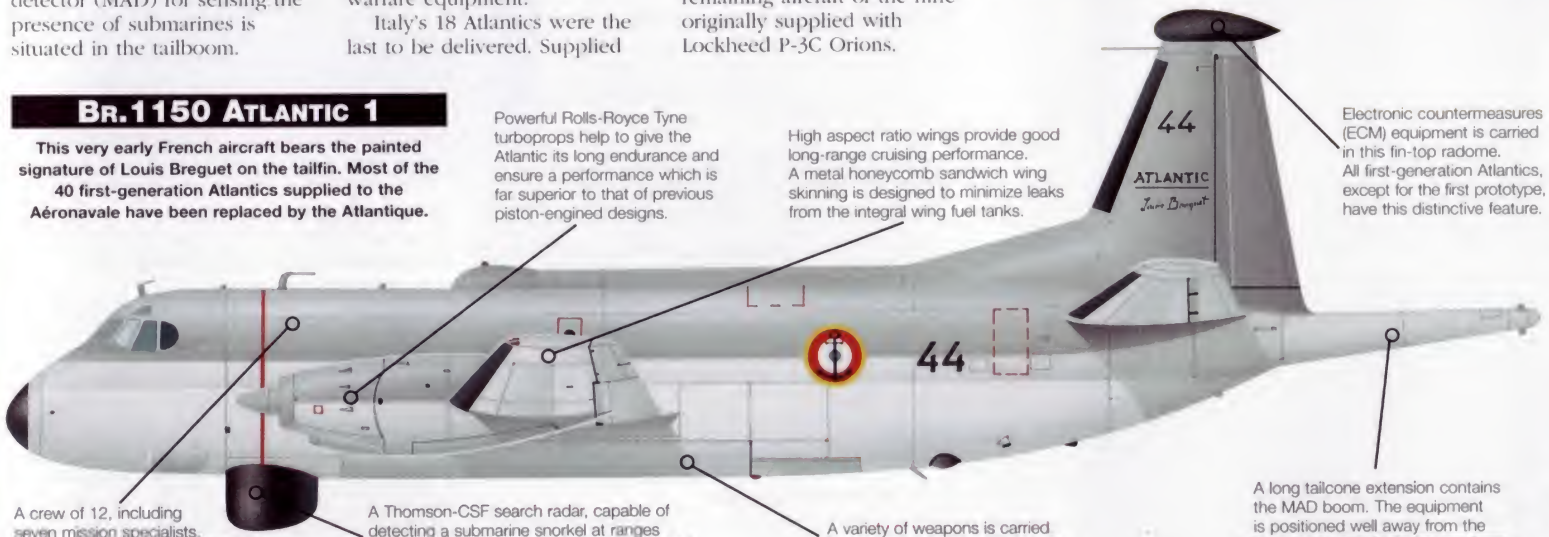
Armament: a maximum of 3500 kg (7,716 lb) of torpedoes, depth charges and missiles in the weapons bay and on four wing pylons

Dimensions:

span	36.30 m (119 ft 1 in)
length	31.75 m (104 ft 2 in)
height	11.33 m (37 ft 2 in)
wing area	120.34 m² (1,295 sq ft)

BR.1150 ATLANTIC 1

This very early French aircraft bears the painted signature of Louis Breguet on the tailfin. Most of the 40 first-generation Atlantics supplied to the Aéronavale have been replaced by the Atlantique.



Powerful Rolls-Royce Tyne turboprops help to give the Atlantic its long endurance and ensure a performance which is far superior to that of previous piston-engined designs.

High aspect ratio wings provide good long-range cruising performance. A metal honeycomb sandwich wing skinning is designed to minimize leaks from the integral wing fuel tanks.

Electronic countermeasures (ECM) equipment is carried in this fin-top radome. All first-generation Atlantics, except for the first prototype, have this distinctive feature.

A crew of 12, including seven mission specialists, occupies the upper, pressurized section of the cabin.

A Thomson-CSF search radar, capable of detecting a submarine snorkel at ranges of up to 75 km (47 miles), is accommodated in this retractable radome.

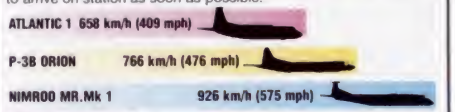
A variety of weapons is carried in the three-part, unpressurized weapons bay.

A long tailcone extension contains the MAD boom. The equipment is positioned well away from the fuselage to avoid interference from the airframe structure.

COMBAT DATA

MAXIMUM SPEED

A typical long-endurance patrol flight is flown at the most economical cruising speed. However, maritime patrol aircraft often need to respond to a threat or emergency situation which requires them to arrive on station as soon as possible.

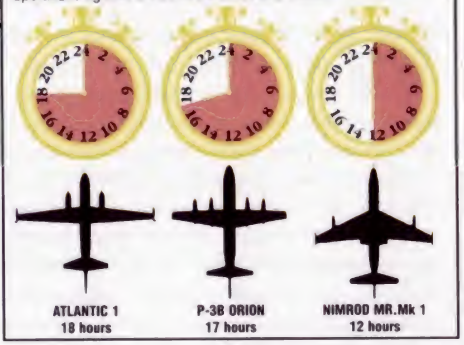


WEAPON LOAD

Operating at great distances from base, the maritime patrol aircraft commander is unable to make frequent landings to re-arm. A large, hard-hitting weapon load is therefore important if the aircraft is to demonstrate effective combat persistence.

ENDURANCE

Many missions involve long searches over vast tracts of ocean, hunting for elusive targets, followed by prolonged offensive operations against a submarine or surface vessel.



Current Atlantic operators

■ **GERMANY:** This aircraft is one of the modified electronic intelligence-gathering aircraft which are flown by the German navy. They are also capable of jamming enemy transmissions.

■ **ITALY:** Two units operate the Italian Atlantics, including the 30° Stormo (Wing) of the 86° Gruppo (Squadron), based at Cagliari-Elmas in Sardinia.

■ **PAKISTAN:** At one time reports suggested that Pakistan's Atlantics had been returned to France because of a lack of skilled servicing personnel, but they continue to fly from Sharea Faisal.

DE HAVILLAND

DH.110 SEA VIXEN

● Carrier fighter ● All-weather interceptor ● Attack fighter

With its twin engines and armed with missiles, the Sea Vixen replaced the single-engined, gun-equipped Sea Venom aboard Royal Navy aircraft-carriers. At the time of its selection it represented a major step forward for the Fleet Air Arm, and its career came to an end only when the navy was forced to give up its flat-top carriers. Yet by the time it entered service naval fighter design had moved into the era of the Mach 2 Phantom.

▲ *The Sea Vixen's powerful radar and missile armament was a great leap forward, and together with the Scimitar and Buccaneer it provided the backbone of the Royal Navy's carrier force in the 1960s.*

PHOTO FILE

DE HAVILLAND DH.110 SEA VIXEN

Take-off ▶
The Sea Vixen was regarded as a safe aircraft, but the observer had little chance to escape if the aircraft ditched after take-off. The catapult strop can be seen under the aircraft, falling into the sea.

▲ Air-to-air missile armament
The FAW.Mk 1 introduced guided missiles to the Royal Navy, with the de Havilland Firestreak. Up to four of these could be carried in addition to internal rockets.

▲ Improved interceptor
The FAW.Mk 2 was a great improvement, with new infra-red guided Red Top missiles, air-to-surface missiles and additional fuel in the tailbooms.

▲ Refuelling the Buccaneer
As well as receiving fuel, the Sea Vixen could fill up other aircraft from its own refuelling pods.

◀ Fleet fighter
At its peak the Sea Vixen served with a Royal Navy display team, known as 'Simon's Sircus', and performed at air shows.

FACTS AND FIGURES

- The Sea Vixen FAW.Mk 2 first flew on 8 March 1963 and was received by the first squadrons later in the year.
- The prototype Sea Vixen first flew on 26 September 1951 after long delays.
- Sea Vixen FAW.Mk 2s were used by Nos 890, 892, 893 and 899 air squadrons.
- Sea Vixens from HMS *Eagle* intercepted Soviet Tu-16 'Badger' bombers near a NATO exercise in 1968.
- A specification (N 40/46) for the Sea Vixen was issued as early as 1945.
- With AI.18 radar and Firestreak missiles, the Sea Vixen was an all-weather fighter.

PROFILE

The fighter that came too late

Delays ruined the career of the Sea Vixen. The first DH.110 prototype flew in 1951, but was destroyed in a crash, which delayed the navy order. It was also not chosen as the Royal Air Force's new fighter, losing out to the Javelin in 1952. By 1955 a naval version had flown, but it was 1960 before the first Sea Vixen FAW.Mk 1s went to sea.

One feature that marked the Sea Vixen as a modern fighter for its day was its armament of four Firestreak infra-red homing missiles. Another was the large nose radome. The radar was responsible for one of the most unusual characteristics of the Sea Vixen: lack of a canopy for the observer. His compartment was on the right side of the fuselage, and was enclosed to make the most of the dim screen of the radar display.

The FAW.Mk 2 Sea Vixen was armed with the new Red Top missile and had longer tailbooms which extended ahead of the wing leading edges in order to carry more fuel. Although they did not see combat, Sea Vixens were the main armament of Britain's aircraft-carriers until the early 1970s. The last Sea Vixen squadron disbanded in 1972.

Above: An FAW.Mk 1 leaps into the air from a land base, carrying four dummy Firestreak missiles and the outer pylon fuel tanks that were a standard feature.

Right: The first British fighter without internal guns, the Sea Vixen carried 28 51-mm (2-in) rockets instead.

Sea Vixen FAW.Mk 2

Type: two-seat all-weather shipboard interceptor fighter

Powerplant: two 49.96-kN (11,237-lb-thrust) Rolls-Royce Avon RA.28 Mk 208 15-stage axial-flow turbojets

Maximum speed: 1030 km/h (640 mph) at altitude

Initial climb rate: 3050 m/min (10,000 fpm)

Range: 2260 km (1,404 miles)

Service ceiling: 14,630 m (48,000 ft)

Weights: maximum take-off 16,783 kg (37,000 lb)

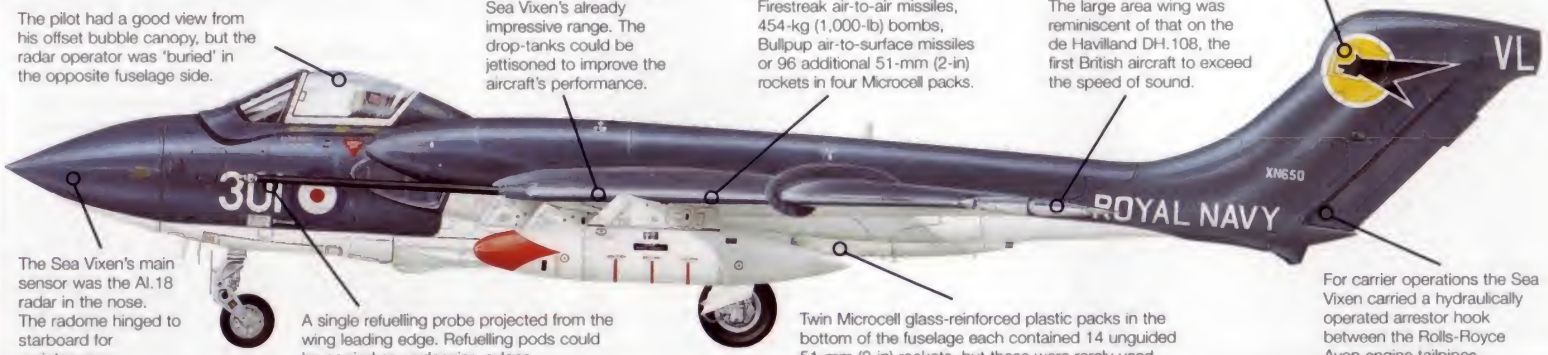
Armament: 28 51-mm (2-in) rockets in underfuselage Microcell pack, plus 2000 kg (4,400 lb) of weapons on four underwing pylons

Dimensions:

span	15.24 m (50 ft)
length	16.94 m (55 ft 7 in)
height	3.28 m (10 ft 9 in)
wing area	60.19 m² (648 sq ft)

SEA VIXEN FAW.MK 2

This Sea Vixen served with No. 892 Squadron of the Royal Navy, and was detached to the 'Simon's Sircus' display team during 1968. The five Sea Vixens carried smoke-generating equipment and painted fuel tanks.



The pilot had a good view from his offset bubble canopy, but the radar operator was 'buried' in the opposite fuselage side.

The outer two out of six wing stores hardpoints were almost always used for the carriage of external fuel tanks to improve the Sea Vixen's already impressive range. The drop-tanks could be jettisoned to improve the aircraft's performance.

A wide range of defensive and attack stores could be carried on the remaining four pylons, typically Red Top or Firestreak air-to-air missiles, 454-kg (1,000-lb) bombs, Bullpup air-to-surface missiles or 96 additional 51-mm (2-in) rockets in four Microcell packs.

The distinctive twin-boom layout was inherited from the earlier Vampire and Venom fighters, and provided good stability.

The large area wing was reminiscent of that on the de Havilland DH.108, the first British aircraft to exceed the speed of sound.

The Sea Vixen's main sensor was the AI.18 radar in the nose. The radome hinged to starboard for maintenance.

A single refuelling probe projected from the wing leading edge. Refuelling pods could be carried on underwing pylons.

Twin Microcell glass-reinforced plastic packs in the bottom of the fuselage each contained 14 unguided 51-mm (2-in) rockets, but these were rarely used.

For carrier operations the Sea Vixen carried a hydraulically operated arrestor hook between the Rolls-Royce Avon engine tailpipes.

COMBAT DATA

MAXIMUM SPEED

Although it had immense power, the Sea Vixen also suffered from high drag, and was only supersonic in a dive. The F-8 was a much faster machine thanks to its J79 engine and sleek airframe.

RANGE

The large fuselage could hold lots of fuel and the Sea Vixen therefore had long range. The F3H also had a good range, but only because its poor engines were not able to convert the fuel to power quickly enough.

ARMAMENT

Designers in the late 1950s were obsessed with building fighters capable of launching guided missiles. The Crusader could fire the only radar-guided version of Sidewinder, the AIM-9C.

Fleet Air Arm fast jets

■ **BLACKBURN BUCCANEER:** A specially designed low-level high-speed strike aircraft, the Buccaneer also served with the RAF.

■ **DE HAVILLAND SEA VENOM:** The Royal Navy's first all-weather jet fighter, the Sea Venom served from the mid-1950s until 1960.

■ **McDONNELL DOUGLAS PHANTOM:** The US-built but Rolls-Royce Spey-powered Phantom was the Royal Navy's best carrier-based fighter.

■ **SUPERMARINE SCIMITAR:** Entering service in 1957, the twin-engined Scimitar was the FAA's first swept-wing single-seat fighter.

DOUGLAS

C-54 SKYMASTER

● Four-engined long-range transport ● Three hundred in Operation 'Vittles'

When the Soviets sealed off Berlin in 1948, the large, four-engined Douglas C-54 Skymaster was the right aircraft at the right time. The Berlin Airlift began in late June 1948, the first major confrontation of the Cold War. The Allies had a variety of aircraft types at their disposal, in particular the C-47. Its age, however, was beginning to show, and it was the more capable C-54 that was to become the mainstay of the airlift.

▲ *At the peak of the round-the-clock supply of Berlin, flights in and out of Tempelhof, Tegel and Gatow took place every 90 seconds. An aircraft remained on the ground in Berlin for just 30 minutes.*

PHOTO FILE

DOUGLAS C-54 SKYMASTER

Presidential Skymaster ▶
President Truman used this VC-54C, known as the 'Sacred Cow', to visit 55 countries between 1944 and 1947. It was retired in 1961.

▲ Backbone of the Airlift
Over 300 USAF Skymasters took part in the Berlin Airlift, drawn from units based around the world.

▼ Navy and Marine Corps
R5D was the designation given to Navy and Marine Corps Skymasters; more than 200 were delivered during World War II.

▲ In almost all weathers
Tempelhof airport, Berlin, was covered in snow on 1 March 1949. High winds, poor visibility and icy conditions forced flights to stop the night before.

Operation 'Vittles' ▶
USAF participation in the airlift was codenamed 'Vittles'. Here a Skymaster, loaded with supplies, is on its final run into Tempelhof.

FACTS AND FIGURES

- US, British and Commonwealth transports carried 545,651 tonnes (601,477 tons) of food to the people of Berlin.
- The total tonnage of cargo airlifted was equivalent to one tonne per Berliner.
- The RAF's airlift flights were codenamed Operation 'Plainfare'.
- The airlift's single-day record of 12,940 tonnes (14,264 tons) in 1398 sorties was set during the 'Easter Parade' of April 1949.
- Berlin, 160 km (100 miles) into East German territory, was served by three air corridors.
- Over 1000 C-54s were built for the US Air Force in all, plus over 200 for the Navy.

PROFILE

Mainstay of the Berlin Airlift

A lifeline of transport aircraft kept Berlin alive during the 1948/49 Russian blockade. At the time, the Berlin Airlift was the largest major humanitarian operation ever undertaken by air. Many Allied aircraft flew supplies into Berlin, but the Douglas C-54 Skymaster was perhaps the best known.

The C-54 entered service with the USAAF in 1942, the earliest examples coming off the DC-4 production line after it was commandeered when the United States entered World War II.

Much of the Berlin Airlift consisted of flying food from Western Europe into the surrounded German city. As no supplies of any type were able to reach Berlin by road, some aircraft were modified to carry other commodities such as coal and fuel oil.

Flying conditions were often hazardous. The pilot of a C-54 flying into Berlin knew that a transport was taking off or landing every few minutes, that the weather could deteriorate to zero-zero conditions without warning and that the Soviets might harass or even shoot at Skymasters as they attempted the difficult, short-field landing at Tempelhof airport. After over 2.3 million tonnes of cargo had been airlifted, the blockade ended on 30 September 1949.

Left: Eight squadrons of USAF C-54s served in the Berlin Airlift, replacing C-47s from late 1948. As well as being more reliable, they had a greater payload.

Right: The Military Air Transport Service (MATS) combined the long-range transport elements of the US Air Force and Navy.

C-54A Skymaster

Type: four-engined long-range transport

Powerplant: four 962-kW (1,290-hp) Pratt & Whitney R-2000-9 Twin Wasp radial piston engine

Maximum speed: 427 km/h (265 mph)

Climb rate: 3048 m (10,000 ft) in 14.8 min

Range: 4828 km (3,000 miles) with 4082-kg (9,000-lb) payload

Service ceiling: 6706 m (22,000 ft)

Weights: empty 19,641 kg (43,300 lb); maximum take-off 30,844 kg (68,000 lb)

Accommodation: flight crew of six and up to 10,000 kg (22,046 lb) of freight

Dimensions:

span	35.81 m (117 ft 5 in)
length	28.60 m (93 ft 10 in)
height	8.38 m (27 ft 6 in)
wing area	135.63 m² (1,460 sq ft)

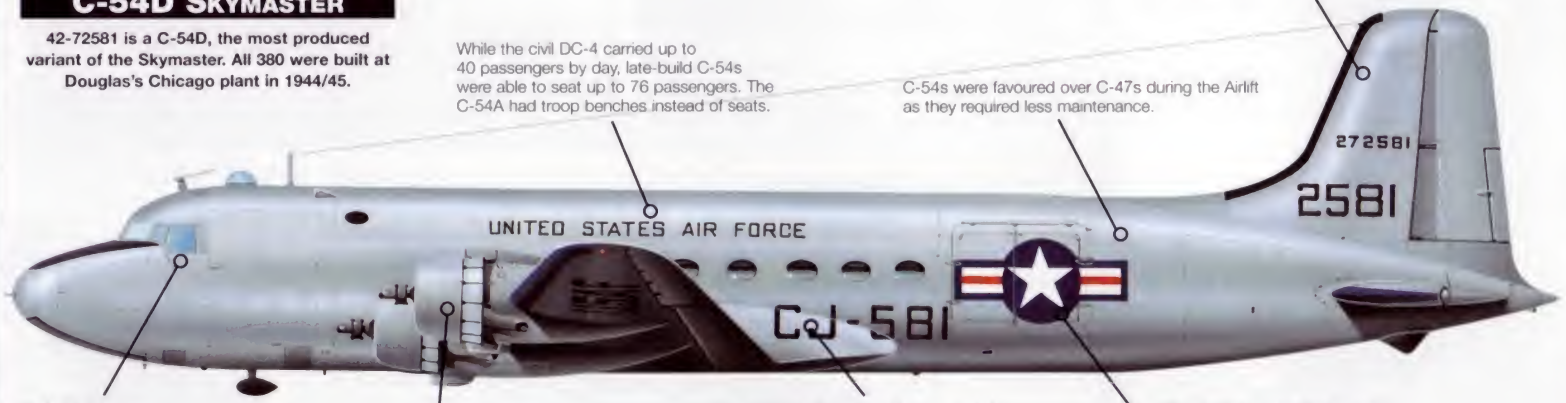
C-54D SKYMASTER

42-72581 is a C-54D, the most produced variant of the Skymaster. All 380 were built at Douglas's Chicago plant in 1944/45.

Wartime C-54s carried an olive drab camouflage colour scheme. After hostilities ceased an unpainted natural metal finish was adopted across the fleet.

While the civil DC-4 carried up to 40 passengers by day, late-build C-54s were able to seat up to 76 passengers. The C-54A had troop benches instead of seats.

C-54s were favoured over C-47s during the Airlift as they required less maintenance.



Typically the crew consisted of six: pilot, co-pilot, navigator, radio operator and two relief crewmembers.

Four Pratt & Whitney R-2000-9 Twin Wasps powered all C-54s. This was an enlarged development of the R-1830 fitted to the C-47 and numerous other aircraft.

Post-1945, a 'buzz' number was used to quickly identify an aircraft. It consisted of the last three digits of the serial number and a two-letter code; 'CJ' was the code for the C-54.

Skymasters were able to carry 10 tonnes of freight. This was loaded, usually on pallets, through the enlarged port-side cargo door.

ACTION DATA

MAXIMUM PAYLOAD

The C-54 replaced the C-47 because of its larger payload capacity and the fact that it was easier to maintain. Similarly, the RAF began to use the more suitable Hastings instead of Yorks and Dakotas.

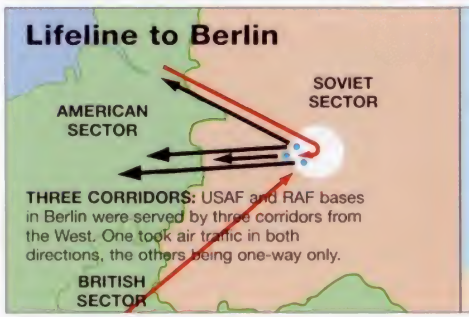
NUMBERS BUILT

The standard Allied transport of World War II, the C-47 was built in huge numbers in several factories. The C-54 was also used by the Allies and other countries, especially after 1945.

MAXIMUM SPEED

The most modern of the three designs, the Hastings benefited from more powerful engines. The C-54 used four similar engines to the two fitted to the C-47 but was a much larger aircraft.

Lifeline to Berlin



THREE CORRIDORS: USAF and RAF bases in Berlin were served by three corridors from the West. One took air traffic in both directions, the others being one-way only.

HAZARDOUS CONDITIONS: Pilots had to endure bad weather as well as the hazards involved in flying through the confined air space of the corridors and over Berlin.

BUZZED BY THE RUSSIANS: Another potential hazard was presented by the Russians, who sent fighters, such as Yak-9s, to harass the airlift aircraft.

DOUGLAS

A-1 SKYRAIDER (KOREA)

● Strike fighter ● Piston-engine attack ● Carrier aircraft

Able to deliver an incredible array of ordnance, the Skyraider's origins began with the Douglas Dauntless of World War II fame. Incredibly strong with a good performance, the A-1 long outlived its anticipated life until people believed that the only replacement for the Skyraider was another Skyraider! It was in the Korean War that the early models of the aircraft began to prove that, carrier- or land-based, the Skyraider had few equals in combat.

▲ *Nicknamed the 'Spad' by its adoring pilots, the Skyraider proved that the age of the jet was not complete. Delivering ordnance with pinpoint accuracy long after the last jets had gone home, the Skyraider also proved better able to absorb massive battle damage.*

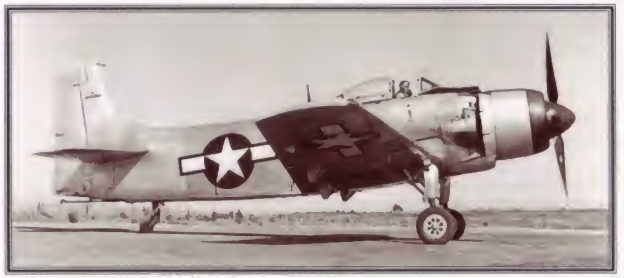
PHOTO FILE

DOUGLAS A-1 SKYRAIDER

▼ Airfield beat-up
Even with a load of bombs and rockets, the Skyraider could still thunder less than 30 m (100 ft) above the runway at around 550 km/h (342 mph). Pilots loved the aircraft's low-level performance.

▲ Rocket raider
A favourite Skyraider tactic was unguided rocket attacks. Up to a dozen 127-mm (5-in) rockets could be carried, or two massive 30-cm (11.8-in) 'Tiny Tim' weapons, as well as the powerful 20-mm (0.79-in) cannon.

First of many ▶
A few early Skyraiders were finished in bare metal, but most were painted dark blue.



▼ Hooking up
With the ability to make lower speed approaches than a jet, the AD-1 was easier to land on deck.

'Tiny Tim' ▶
With its speedbrakes deployed just behind the wing, this AD-1 reveals its load, including a pair of huge 'Tiny Tim' rockets. The AD-4 could carry more than its own weight.

FACTS AND FIGURES

- In a raid in May 1951, AD-1s flying from USS *Princeton* used aerial torpedoes to burst a North Korean dam at Hwachon.
- The XBT2D of 1945 was the first US single-seater dive/torpedo bomber.
- The Skyraider was able to carry more ordnance than a wartime B-17 Fortress.
- In 1952, a US pilot successfully landed his Skyraider after having been blinded by a shell hit.
- Skyraiders were also used in Vietnam, where two aircraft shot down MiG-17s.
- In Korea, the Skyraiders carried every weapon in the US Navy arsenal.

PROFILE

'Spad' goes to war in Korea

Making its maiden flight on 18 March 1945 as the XBT2D-1, the aircraft that became the Skyraider was designed by the legendary Ed Heinemann. In 1946 it looked set for a peaceful and probably brief career as an 'old-fashioned' piston-engined attack aircraft in the new jet age. The Skyraider's career was in fact anything but mundane, thanks to its fine showing in the Korean War. Proving that 'low and slow' still produced results in ground-attack work, the AD squadrons of the US Navy and Marine Corps gave outstanding air support to United Nations ground forces.

By integrating air strikes with the faster jets which acted as escorts, the Skyraider pilots flying off Task Force 77's carriers could go in unmolested by enemy air attack. The main hazard was from ground fire, a fact of life faced equally by land-based Marine Corps AD units. Combat flying in the Skyraider gave pilots the reassurance that their aircraft could take a great deal of punishment and still fly home.

Left: The Skyraider was also fitted with underwing radar. A few XBT2D destroyers were completed with an underwing searchlight and room for a second crewmember.

The AD-1 first entered Navy service in November 1946 and it soon became clear that the basic design was immensely versatile. Being such a large aircraft (for a single-seater), the Skyraider could accommodate a second seat and the necessary equipment inside the fuselage for a radar/ECM operator. This version, the AD-1Q, covered 35 airframes out of the total 242 AD-1 Skyraiders built.

Above: Although considered obsolete just after its inception, the Skyraider was still fighting in Chad as late as 1979.

AD-1 Skyraider

Type: single-seat ground-attack aircraft

Powerplant: one 2252-kW (3,020-hp) Wright R-3350-26W Cyclone radial engine

Maximum speed: 498 km/h (309 mph)

Range: 1448 km (900 miles)

Service ceiling: 9753 m (32,000 ft)

Weights: empty 4577 kg (10,091 lb); loaded 8178 kg (18,029 lb)

Armament: four 20-mm (0.79-in) cannon in wings, plus mixed ordnance including bombs, napalm and unguided folded-fin aircraft rockets on centreline and wing stores stations

Dimensions:

span	15.24 m (50 ft)
length	11.63 m (38 ft 2 in)
height	4.7 m (15 ft 5 in)
wing area	37.16 m² (400 sq ft)

AD-1 SKYRAIDER

The mainstay of the US Navy's carrier-borne attack force in Korea, the AD-1 entered service in 1946 and was only finally retired in 1968 during the Vietnam War.

The large cockpit was a typical feature of late American piston fighters. Topped by a bubble canopy offering excellent visibility, it had no ejector seat and pilots 'bailed out' manually.

The single 1470-litre (388-US gal) fuel tank was located just behind the pilot, next to the radio and avionics racks. The large twin speedbrakes were located on the fuselage sides just behind it.

Much of the Skyraider's success was due to the superb Wright R-3350 two-row radial engine, which was powerful and reliable.

Massive strength was built into the wing. Several Skyraiders made it home after taking hits from flak shells of up to 37 mm (1.46 in).

The AD-1 was equipped with a sturdy tailhook for arrester landings on carriers. The distinctive Skyraider tail shape was one feature that hardly changed between versions.

COMBAT DATA

MAXIMUM SPEED

For a piston-engined fighter-bomber, the AD-1 was quite fast; however, even the early jets could outrun it. The wartime Il-10 could not match post-war aircraft.

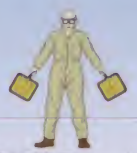
ARMAMENT

Few jet fighters could match an AD-1's weapon load until the mid-1960s, and most did not have the same firepower from their guns either. The Il-10 was designed for anti-armour attack and usually carried eight rockets in addition to its powerful cannons.

RANGE

The bulky airframe of the AD-1 held a good reserve of fuel, like many naval aircraft. The Il-10 was designed for tactical support from front-line airfields and had short range. Early jets usually had short range and most were inferior to the AD-1.

Deck landing signals for carrier pilots



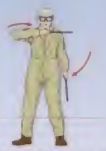
TOO LOW: The most dangerous condition was too low, as the pilot risked striking the carrier's stern.

TOO HIGH: Both hands raised told the pilot that he was too high to make a safe approach to the deck.

ONE WING HIGH: If the pilot had too much bank on, the deck officer gave a 'one wing high' signal to him.

WAVE-OFF: This signal told the pilot to terminate the approach because it looked unsafe to the deck officer.

SAFE TO LAND: If the aircraft had wings level at the right height, the deck officer gave the pilot this signal.



ENGINE CUT: Once he saw the arrestor catch the tail-hook, the deck officer gave the signal to 'cut engines'.

DOUGLAS

F4D SKYRAY

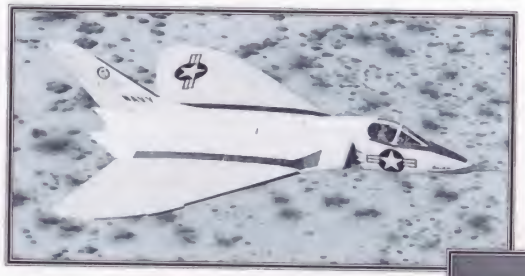
● Tail-less design ● Fleet defence

▲ *The Skyray was typical of the second generation of jet fighters, possessing exceptional performance, but being tricky to fly. The accident rate was high, especially during carrier operations.*

Designed at the height of the Cold War, the bat-winged, fast-climbing Douglas F4D Skyray's mission was to guard the US Fleet against attack by Soviet bombers. Today, those who flew this great jet, one of the most advanced interceptors of its time, praise the Skyray as a little-appreciated legend. Only a few hundred US Navy and Marine pilots actually flew the 'Ford', but it was much-loved and performed its duties superbly.

PHOTO FILE

DOUGLAS F4D SKYRAY



◀ Lippisch delta
The configuration of the Skyray owed much to German aerodynamics' expert Dr Lippisch, who had devised the layout of the Me 163.

▼ Fleet defender
The first line of the fleet's defence was the Skyray. The early Sidewinder missile was just coming into service with the F4D.

▼ Deck approach
Coming in slow with the hook down, the F4D was quite a handful. Early naval jets approached the deck at twice the speed of wartime fighters.

▼ Clean design
Although the Skyray looked beautiful and handled well, the design had control and powerplant problems.

◀ Mixed weapons
Late in its career the F4D was cleared to carry the Sidewinder heat-seeking missile, while retaining rocket and gun armament. The underfuselage pod was the NAVPAC, containing extra navigation equipment.

FACTS AND FIGURES

- Skyrays of Navy squadron VF(AW)-3 twice won the NORAD (North American Air Defense Command) Trophy.
- The first XF4D-1 Skyray prototype made its maiden flight on 23 January 1951.
- The Westinghouse XJ40 turbojet engine was powerful but unreliable.
- The XJ40-powered 'Ford' set a world speed record of 1211.746 km/h (752.944 mph) on 3 October 1953.
- The Skyray was also flown with the Allison J35 turbojet engines.
- In May 1958, US Marine Colonel Edward LeFaivre seized five world climb records.

PROFILE

The tail-less wonder

Douglas's star designer Ed Heinemann used German tail-less delta research when he created this carrier-based interceptor, even though the manta-like wing was not a genuine delta. The sleek, unorthodox Skyray had a fantastic rate of climb – just what was needed to 'scramble' against high-flying bombers. The F4D Skyray was the only Navy aircraft to serve in the US Air Force's Air Defense Command, charged with fending off the first blows of a World War III that never came.

Just 419 F4Ds (redesignated F-6A in 1962) were built. Technical problems and rapid advances in technology limited the aircraft's service life to the period between 1956 and 1962; however, 11 US Navy, six Marine and three Reserve squadrons used this remarkable interceptor during its brief tour of duty. Navy pilots operated this aircraft from carriers, flew it under difficult operational conditions, and found it to be a superb performer with fine handling qualities.

Above: Like most contemporary fighters in the 1950s, the F4D had no end of minor problems. The inlets had to be extensively redesigned to prevent compressor stalls.

Below: The tail-less delta was a short-lived phenomenon in US aircraft design, also appearing in the F-102.

F4D-1 SKYRAY

VF-162 'Hunters' was the shortest lived F4D unit, receiving the type in September 1962 and turning to the new F-8 Crusader only two years later, after a single cruise deployment aboard USS *Intrepid*.

The trailing-edge control surfaces acted as combined elevators and ailerons for roll and pitch. The outer stores pylon could carry a 19-round 70-mm (2.76-in) rocket pod.

The outer wing folded up to allow the Skyray to fit onto aircraft carrier lifts. The cannon were mounted in pairs in the wing, with 70 rounds per gun.

Like many early jet fighters, the F4D had particularly poor cockpit visibility, especially to the rear.

Large fuel cells were mounted in the blended wing and fuselage junction, with 1200 litres (317 US gal) in each side.

The Skyray was equipped with an APQ-50 radar system, giving limited target range information. An Aero 13F weapon fire-control package was located behind the radar scanner dish.

Inlets in the wingroots were a common feature of early 1950s aircraft, notably the Hawker Sea Hawk, a British contemporary, and the large 'V' bombers.

Unusually, the Skyray also had a tailwheel as well as a tailhook, to compensate for its high nose attitude on landing and take-off.

F4D-1 Skyray

Type: single-seat all-weather interceptor fighter

Powerplant: one Pratt & Whitney J57-P-8A turbojet rated at 45.38 kN (10,205 lb thrust) dry and 71.18 kN (16,009 lb thrust) with afterburning

Maximum speed: 1162 km/h (722 mph)

Cruising speed: 837 km/h (520 mph)

Range: 1930 km (1,200 miles)

Service ceiling: 16,764 m (55,000 ft)

Weights: empty 7268 kg (16,023 lb); normal loaded 9983 kg (22,009 lb); maximum take-off 12,300 kg (27,117 lb)

Armament: four internal 20-mm (0.79-in) cannon, plus up to 1814 kg (4,000 lb) of bombs, rocket pods, AIM-9 Sidewinder air-to-air missiles or auxiliary fuel tanks mounted on seven external hardpoints

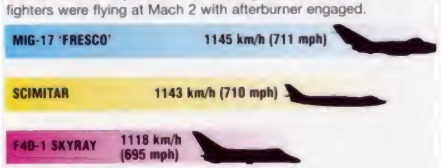
Dimensions:

span	10.21 m (33 ft 6 in)
length	13.79 m (45 ft 3 in)
height	3.96 m (13 ft)
wing area	51.75 m² (557 sq ft)

COMBAT DATA

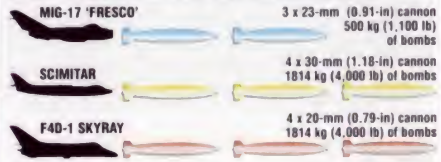
MAXIMUM SPEED

The Skyray was closely matched by contemporary fighters, all of which had limited power from their engines. A few years later, fighters were flying at Mach 2 with afterburner engaged.



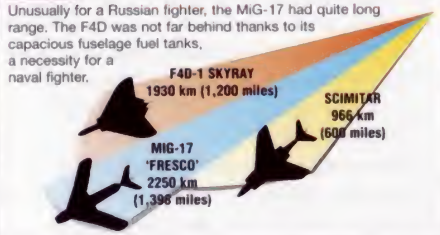
ARMAMENT

The Scimitar and Skyray both outgunned the MiG-17, which was designed with a relatively light armament in typical Russian fashion. The era of missile armament was just beginning.



RANGE

Unusually for a Russian fighter, the MiG-17 had quite long range. The F4D was not far behind thanks to its capacious fuselage fuel tanks, a necessity for a naval fighter.



Naval fighters of the 1950s

HAWKER SEA HAWK: The straight-wing Sea Hawk was a conservative design, but served as late as the 1970s in Indian service.

MCDONNELL F3H DEMON: Plagued by problems with low engine power, the Demon was armed with early series Sparrow missiles.

NORTH AMERICAN FJ-4 FURY: Effectively a navalized F-86, the FJ4 was powered by a licence-built version of the British Sapphire turbojet.

SUPERMARINE SCIMITAR: The Fleet Air Arm's first swept-wing jet, the Scimitar could carry nuclear weapons and Bullpup missiles.

DOUGLAS

A-3 SKYWARRIOR

● Largest carrier aircraft ● Nuclear bomber ● Long service

Nicknamed the 'Whale' by its crews, the Douglas A-3 Skywarrior was an impressive aircraft by all accounts. It began to enter service in the mid-1950s and, ultimately, enjoyed a colourful and long service career; the final examples were retired from the US Naval Reserve during the early 1990s. Skywarriors proved their worth during the Vietnam War, and were among the first aircraft to drop bombs in anger over North Vietnam in 1965.

▲ *Designed as a carrier-borne nuclear bomber, the A-3 achieved only modest success in its intended role. It blossomed, however, as a tanker, reconnaissance and Elint aircraft.*

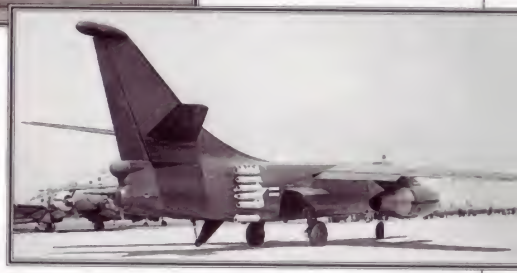
PHOTO FILE

DOUGLAS A-3 SKYWARRIOR

▲ Skywarrior up North
This rare picture shows an A-3B attacking a ground target over North Vietnam.

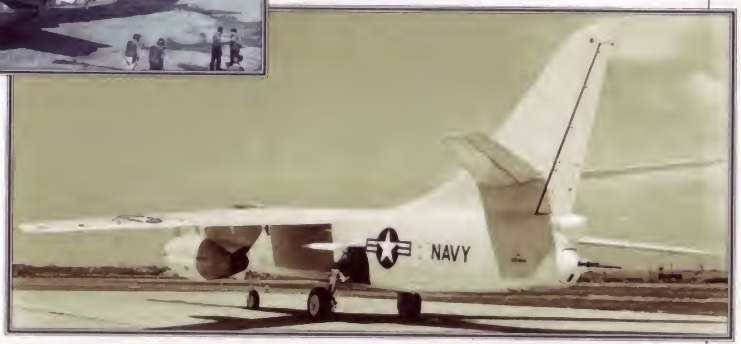
▲ Aboard ship
Folding wings were an absolute necessity for operations at sea, and enabled the massive A-3s to be 'parked' on deck with relative ease.

Assisted take-offs ▶
This early A3D-1, seen here in 1954, was equipped with JATO (Jet-Assisted Take-Off) bottles in an effort to improve the type's short-field performance.



◀ Dual-role variant
Identified by the distinctive blister fairing below the cockpit, the EKA-3B was a combined electronic warfare/tanker variant which saw extensive service in Vietnam.

Rear gun turret ▶
As originally delivered, the bomber variants had twin cannon mounted in a tail turret designed by Westinghouse. In service the guns were often removed, and, on later versions, the turret was omitted entirely.



FACTS AND FIGURES

- In 1957 two Skywarriors flew from San Francisco to Hawaii in a record time of 4 hours and 31 minutes.
- The first operational cruise of the A-3 was with VAH-1 on USS *Forrestal* in 1957.
- As late as 1987 EA-3Bs were still serving with frontline US Navy units.
- During the Cuban missile crisis in 1962, a single A-3 unit, VAP-62, flew a variety of missions and later received an award.
- The A-3 actually outserved its intended replacement, the A-5 Vigilante.
- Many examples served as testbeds at NAS Point Mugu in California.

PROFILE

'Whales' in the Navy

Elegant but having a deadly purpose, the A-3 was designed as a carrier-borne nuclear bomber, but the Skywarrior did not serve for long in its intended role. By the time it had entered service the US Navy had begun to relinquish the strategic mission, instead preferring to concentrate on using its air assets in the context of limited wars.

When war broke out in Southeast Asia, 'Whales' flew round-the-clock sorties from carrier decks. They initially acted as conventional bombers, attacking targets in North Vietnam. Designer Ed Heinemann had campaigned from the start to keep weight to a minimum and this proved advantageous; the large A-3s could operate from both the bigger carriers and the small World War II vintage Essex-class wooden-decked ships.

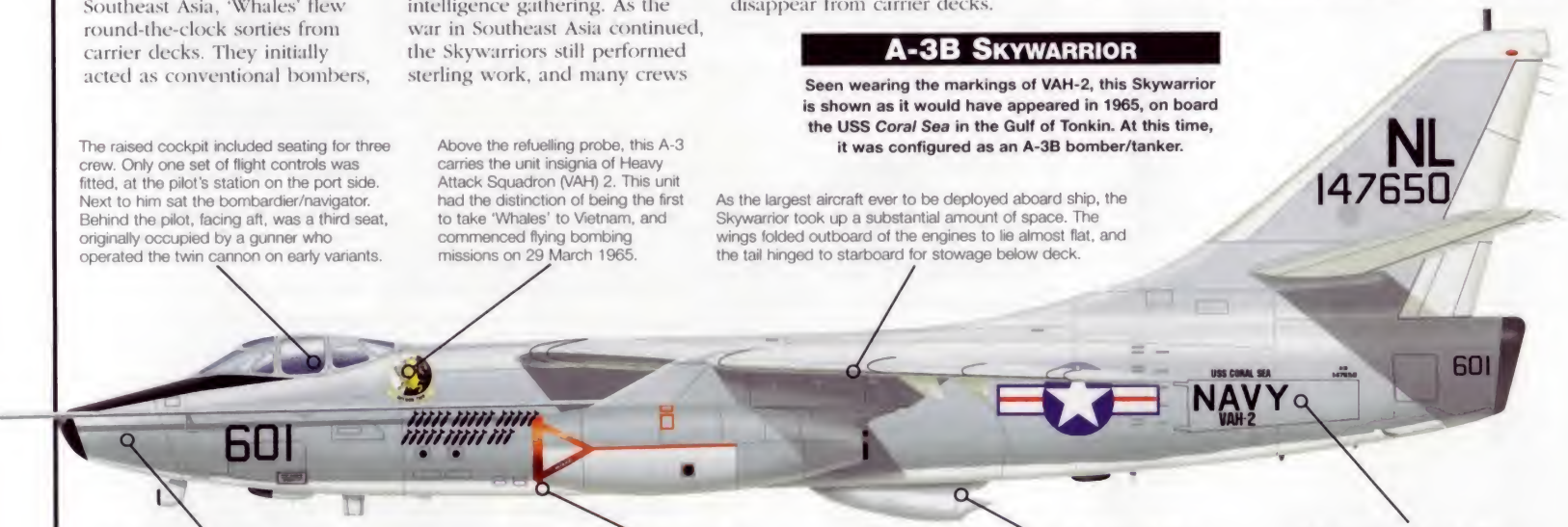
From late 1966, frontline A-3s began to adopt other roles such as tanking, reconnaissance and intelligence gathering. As the war in Southeast Asia continued, the Skywarriors still performed sterling work, and many crews returning from sorties over the North welcomed the sight of a KA-3B tanker. The advent of specialist Intruder variants caused the A-3 slowly to disappear from carrier decks.

Above: When first delivered to US Navy heavy attack squadrons, A-3s were painted overall dark blue. This soon changed to the familiar grey and white scheme.

Above: With its landing gear and tailhook deployed, this A-3B is just about to 'trap' aboard the USS Forrestal. *The weight of the A-3 meant that the arrestor gear had to be very strong.*

A-3B SKYWARRIOR

Seen wearing the markings of VAH-2, this Skywarrior is shown as it would have appeared in 1965, on board the USS *Coral Sea* in the Gulf of Tonkin. At this time, it was configured as an A-3B bomber/tanker.



The raised cockpit included seating for three crew. Only one set of flight controls was fitted, at the pilot's station on the port side. Next to him sat the bombardier/navigator. Behind the pilot, facing aft, was a third seat, originally occupied by a gunner who operated the twin cannon on early variants.

Above the refuelling probe, this A-3 carries the unit insignia of Heavy Attack Squadron (VAH) 2. This unit had the distinction of being the first to take 'Whales' to Vietnam, and commenced flying bombing missions on 29 March 1965.

As the largest aircraft ever to be deployed aboard ship, the Skywarrior took up a substantial amount of space. The wings folded outboard of the engines to lie almost flat, and the tail hinged to starboard for stowage below deck.

Over the years, A-3s were seen with a variety of different nose profiles. Later aircraft had a flat-tipped radome housing the AN/ASB-12 radar system.

Skywarriors converted for the in-flight refuelling role had a fuel tank fitted into the rear section of the bomb bay. Most converted A-3s retained bombing capability.

Under the rear fuselage was the buddy refuelling pack, with a single hose reel. US Navy aircraft used the British-developed probe-and-drogue refuelling system in Vietnam.

Twin speed brakes were fitted to the rear fuselage, directly below the horizontal tailplane, and were hydraulically actuated.

EA-3B Skywarrior

Type: carrier-borne and land-based electronic reconnaissance platform

Powerplant: two 55.16-kN (12,406-lb-thrust) Pratt & Whitney J57-P-10 turbojets

Maximum speed: 982 km/h (610 mph)

Cruising speed: 837 km/h (520 mph)

Range: 4667 km (2,900 miles)

Service ceiling: 12,495 m (41,000 ft)

Weights: empty 17,856 kg (39,366 lb); loaded 33,112 kg (73,000 lb)

Accommodation: crew of seven: pilot, co-pilot and navigator, plus four electronic systems operators

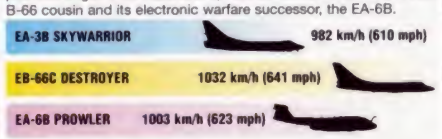
Dimensions:

span	22.10 m (72 ft 6 in)
length	23.27 m (76 ft 4 in)
height	6.95 m (22 ft 10 in)
wing area	75.43 m² (812 sq ft)

COMBAT DATA

MAXIMUM SPEED

Early examples of the A-3 were originally powered by anaemic Westinghouse J40s, although these were soon replaced by more powerful engines. At maximum speed, the A-3 was slower than its B-66 cousin and its electronic warfare successor, the EA-6B.

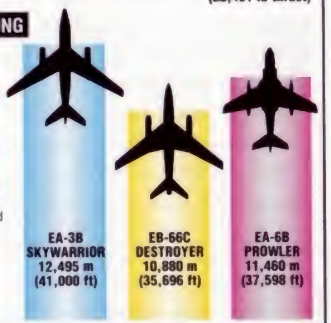


MAXIMUM THRUST

As the largest aircraft ever to operate from carrier decks on a regular basis, the A-3 needed as much thrust as it could get. It was thus more powerful than the very similar USAF Douglas B-66 Destroyer, which was purely land-based. The EA-6B Prowler was not as large or as heavy, and did not require as much thrust.

SERVICE CEILING

Intended as a nuclear bomber, the Skywarrior was designed to fly at high altitudes where it would be immune to attack from ground forces. All three aircraft – the A-3, Destroyer and Grumman EA-6B Prowler – served in Vietnam and, ironically, were often casualties of ground fire.



Douglas carrier aircraft of the 1950s

DOUGLAS A-1H SKYRAIDER: One of the best loved of all aircraft, the venerable 'Spad' was the US Navy's principal medium attack aircraft during the 1950s and 1960s.

DOUGLAS A-4C SKYHAWK: Designed as the smallest aircraft to carry a nuclear weapon, the A-4 served with both the US Navy and Marines, and was exported to many countries.

DOUGLAS F4D (F-6) SKYRAY: Nicknamed the 'Ford', the Skyray entered service in 1951, but was already obsolescent. By 1962 only three frontline units remained equipped with the type.

DOUGLAS

AC-47 'SPOOKY'

● C-47 conversion ● Vietnam War gunship ● Minigun armament

▲ *By the time C-47s were undergoing conversion to 'Spooky' standard in the mid-1960s, the venerable but versatile Skytrains were all at at least 20 years old.*

Experiments with the 'gunship' concept began in the United States in the early 1960s, as a means of bringing accurate, concentrated fire to bear on an enemy position from the air. Some USAF generals were sceptical at first, concerned that an aircraft in such a position would be vulnerable to enemy fire. As soon as the first armed C-47s began to fly combat missions in Vietnam in late 1964, however, the concept proved its worth.

PHOTO FILE

DOUGLAS AC-47 'SPOOKY'

Widely employed ▶
Two units were equipped with 'Spooky' – 4th Air Commando Squadron (at Da Nang, Pleiku, Phu Cat and Nha Trang) and 14th Air Commando Squadron (at Nha Trang, Phan Rang, Bien Hoa and Binh Thuy).

◀ Eight crew members
'Spooky' missions were manned by seven USAF personnel and a Vietnamese observer.

▲ Psy-war operations
As well as AC-47s, the USAF used a small number of EC-47s for leaflet-dropping missions.

▲ Southeast Asia camouflage
In common with most other tactical types in the Southeast Asian theatre, the 'Magic Dragons' were finished in three-tone colours with light-coloured under surfaces.

Minigun pods ▶
General Electric's SUU-11 gun pods were intended for underwing mountings on smaller COIN aircraft, but were adapted for use in the AC-47. Each was manned by a gunner.

FACTS AND FIGURES

- The 'Puff the Magic Dragon' nickname came from a popular song of the same name released in the 1960s.
- In 1965 prices, the first 20 AC-47Ds were converted for US $4,288,975.
- For target illumination at night, each AC-47 carried 56 hand-dropped flares.
- During its first 11 days of use the first AC-47 flew seven training and 16 combat missions; 179,710 rounds were fired.
- The aircraft captain in the left-hand pilot's seat could aim and fire all the guns.
- By the end of 1965, AC-47s were based in Thailand for service over Laos.

PROFILE

'Puff the Magic Dragon'

Originally known as the FC-47 (suggesting a 'fighter' variant), the gun-toting version of the long-serving 'Gooney Bird' transport was soon known by the more appropriate AC-47 designation and by the code name 'Spooky'.

The gunship concept, of which the AC-47D was the first example, was based on a large fixed-wing aircraft flying in a pylon turn to bring fire down on a target using fuselage-mounted sideways-firing rotary Miniguns. From the outset, 'Spooky' was seen as a night weapon, flares being used to illuminate targets. The first night mission was flown on 23/24 December 1964 and was deemed successful. AC-47s were able to loiter for long periods over suspected Viet Cong ground positions.

Soon nicknamed 'Puff the Magic Dragon' after a song of the same name, the AC-47D paved the way for further gunship development, based on the C-119 and C-130. Once these were in service, most AC-47s were transferred to the VNAF.

Above: Around 25 C-47s were converted to AC-47D standard, the first entering service with the 4th Air Commando Squadron in late 1965.

Right: Among other 'special mission' C-47s to serve in Southeast Asia were a small number of EC-47N electronic reconnaissance platforms.

AC-47D 'Spooky'

Type: counter-insurgency gunship

Powerplant: two 820-kW (1,100-hp) Pratt & Whitney R-1830-90D Twin Wasp radial piston engines

Maximum speed: 257 km/h (160 mph)

Initial climb rate: 3050 m (10,000 ft) in 9.5 min

Normal range: 2575 km (1,600 miles)

Service ceiling: (typical) 914 m (3,000 ft)

Weights: empty 8226 kg (18,135 lb); maximum 14,061 kg (31,000 lb)

Armament: three fuselage-mounted 7.62-mm (0.3-in) General Electric SUU-11A Miniguns, each with a 6000 round-per-minute rate of fire

Dimensions:

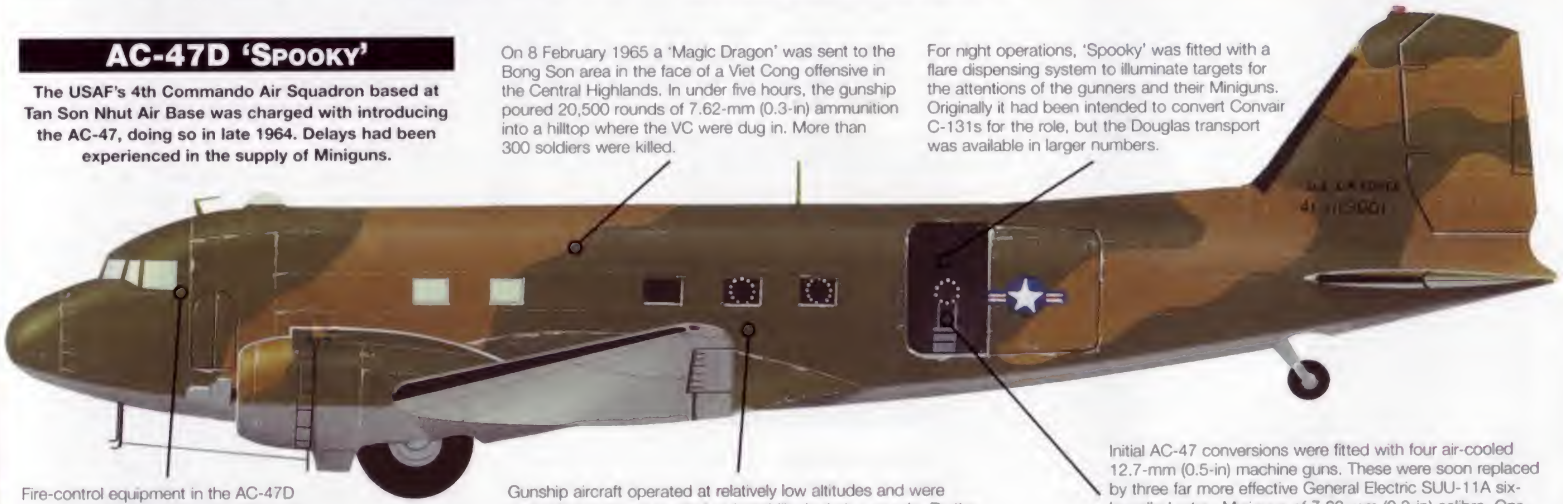
span	29.11 m (95 ft 6 in)
length	19.43 m (63 ft 9 in)
height	17.00 m (55 ft 9 in)
wing area	91.69 m² (987 sq ft)

AC-47D 'Spooky'

The USAF's 4th Commando Air Squadron based at Tan Son Nhut Air Base was charged with introducing the AC-47, doing so in late 1964. Delays had been experienced in the supply of Miniguns.

On 8 February 1965 a 'Magic Dragon' was sent to the Bong Son area in the face of a Viet Cong offensive in the Central Highlands. In under five hours, the gunship poured 20,500 rounds of 7.62-mm (0.3-in) ammunition into a hilltop where the VC were dug in. More than 300 soldiers were killed.

For night operations, 'Spooky' was fitted with a flare dispensing system to illuminate targets for the attentions of the gunners and their Miniguns. Originally it had been intended to convert Convair C-131s for the role, but the Douglas transport was available in larger numbers.



Fire-control equipment in the AC-47D was almost nonexistent. The pilot used a gunsight mounted in the port cockpit window, through which he viewed the target.

Gunship aircraft operated at relatively low altitudes and were camouflaged to reduce their vulnerability in their new role. By the late 1960s, aircraft were carrying a three-tone green and brown Southeast Asia colour scheme, with white unit codes on the tailfin.

Initial AC-47 conversions were fitted with four air-cooled 12.7-mm (0.5-in) machine guns. These were soon replaced by three far more effective General Electric SUU-11A six-barrelled rotary Miniguns of 7.62-mm (0.3-in) calibre. One of these was mounted in the cargo doorway, the other two in the rearmost cabin windows.

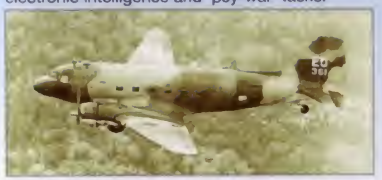
GUNSHIP FIREPOWER

'SHADOW' and 'STINGER': To increase the firepower available to gunship units, the USAF chose the C-119 Packet as the basis for its next generation of 'Magic Dragon'. The first of 52 were delivered in 1968, the AC-119G featuring four Minigun pods and new sensors, including a illuminator light set and night observation gear. More conversions followed; 26 AC-119Ks had underwing jet booster engines and two 20-mm (0.79-in) rotary cannon added.

'SPECTRE': During 1967 an AC-130A prototype was converted and tested in Vietnam. Night flying aids and improved sensors helped guide the aircraft, which boasted no fewer than four Miniguns and four 20-mm (0.79-in) rotary cannon. Successful trials led to seven more C-130A conversions. These were put to work 'truck hunting' along the Ho Chi Minh Trail. Later examples carried a 40-mm (1.57-in) Bofors cannon, side-looking radar and a laser designator.

Special missions transports over Vietnam

■ **DOUGLAS EC-47:** As well as the gunship role, C-47s in Southeast Asia were assigned electronic intelligence and 'psy-war' tasks.



■ **FAIRCHILD UC-123K PROVIDER:** Fitted with spray bars, C-123s were used on Ranch Hand defoliant-spraying missions.

■ **LOCKHEED DC-130E HERCULES:** USAF C-130s (like this USN example) launched and directed spy drones over targets in the North.

■ **LOCKHEED HC-130H HERCULES:** Specially-equipped 'Herks' co-ordinated combat rescue missions to retrieve downed aircrew.

DOUGLAS

A-1 SKYRAIDER (VIETNAM)

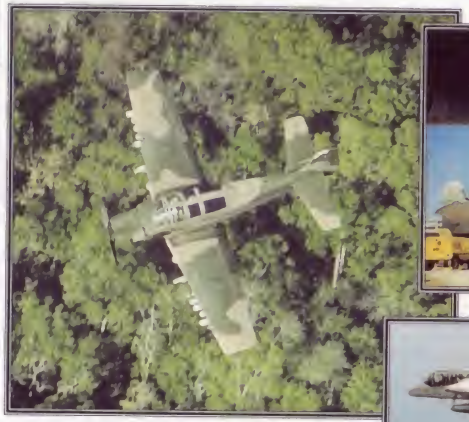
● Vietnam warbird ● Versatile strike fighter ● Rescue support

Near the end of its long American career, the Douglas A-1 Skyraider became a Vietnam rescue craft, known by its call-sign 'Sandy'. The A-1 pilot's task was complex: he had to locate and protect shot-down air crew while directing rescue helicopters and other support aircraft to make a pick-up, all in the face of strenuous efforts by the North Vietnamese to prevent the rescue. In spite of the fact that it was old, noisy and rather slow, the hard-hitting Skyraider was more than able to do the job.

▲ *Major Bernie Fisher carried out an amazing rescue in Vietnam in 1966, actually landing his A-1 in the A Shau valley to pick up his squadron buddy, Major Datford Myers.*

PHOTO FILE

DOUGLAS A-1 SKYRAIDER (VIETNAM)



◀ Primed to fight
Rockets hang from the wings of a Skyraider. The red tapes are flags attached to safety pins, which prevented weapons being armed by accident during handling on the ground. The white phosphorus rockets were used as target-markers.

▲ Jungle colours
The jungle camouflage of this Skyraider had some chance of fooling North Vietnamese MiG fighters, but it was little protection against the main enemy – anti-aircraft fire.

▲ Rescue team
A pair of 'Sandys' escort an OV-10 Bronco. The OV-10 acted as a forward air-control station, coordinating the rescue and target-spotting. A-1 pilots and controllers worked very closely together.

▼ Built like a tank
Pilots also called the A-1 the 'Spad', as its chunky appearance was reminiscent of the robust biplane fighter used by the United States during World War I.

▲ Navy mission
Powerful piston engines roar into life as Navy A-1s prepare for a mission. The naval ancestry of the Skyraider can be seen in the folding wings, designed to take up less deck space on a carrier.

FACTS AND FIGURES

- Between 1945 and 1956, 3180 Skyraiders were built.
- The maiden flight of the A-1 was made at Mines Field, California, on 18 March 1945.
- The last wartime use of aerial torpedoes occurred when Skyraiders attacked the Yalu River dams in the Korean War.
- In Vietnam, propeller-driven A-1 Skyraiders shot down two jet-propelled MiG-17 fighters.
- Some Vietnamese air force pilots logged over 4000 combat hours in the Skyraider.
- Skyraiders were still engaged in a shooting war in Chad as late as 1979.

PROFILE

Pilot pick-up in Vietnam

American fliers rescued in Vietnam in 1969 were glad that Ed Heinemann designed the Douglas A-1 (AD) Skyraider in a hotel room in 1944. One of the last great piston-engined combat planes, the Skyraider was big, tough, and an incredible performer. Known by their callsign 'Sandy', Skyraiders were the key element in the US air force rescue organization in Southeast Asia. Directing and protecting the rescue force, the ageing bombers also kept the enemy away from aircrew stranded on the ground.

The rescue mission in Vietnam was tailor-made for a heavy, sturdy combat aircraft which carried enough fuel to loiter for extended periods and enough bombs to wreck the enemy's day.

Two Skyraider pilots were awarded the Medal of Honor for Vietnam action, and a 'Jolly Green' rescue helicopter escorted by A-1s became a familiar sight. 'Sandy' pilots managed 300 rescues from 1965 until turning the job over to the A-7D Corsair II in 1972.

The A-1E was a multi-role variant of the Skyraider. Originally designated AD-5, it was easily identifiable by its enlarged side-by-side cockpit. Fitted out for transport it could carry 12 passengers.

A-1H Skyraider

Type: single-seat carrier-based attack bomber

Powerplant: one 2013-kW (2,700-hp) Wright R-3350-26WA 18-cylinder radial piston engine

Maximum speed: 518 km/h (322 mph)

Range: 2000 km (1,243 miles)

Service ceiling: 8685 m (28,494 ft)

Weights: empty 5429 kg (11,969 lb); loaded 11,340 kg (25,000 lb)

Armament: four wing-mounted 20-mm (0.79-in) M3 cannon with 200 rounds per gun plus up to 3629 kg (8,000 lb) of bombs or rockets on one under-fuselage and 14 underwing hardpoints

Dimensions:

span	15.25 m (50 ft)
length	11.84 m (38 ft 10 in)
height	4.78 m (15 ft 7 in)
wing area	37.19 m² (400 sq ft)

The original ground-attack Skyraider was fitted with a pair of 20-mm (0.79-in) cannon, but by the end of the aircraft's production run four cannon were standard, and most aircraft involved in Vietnam had them.

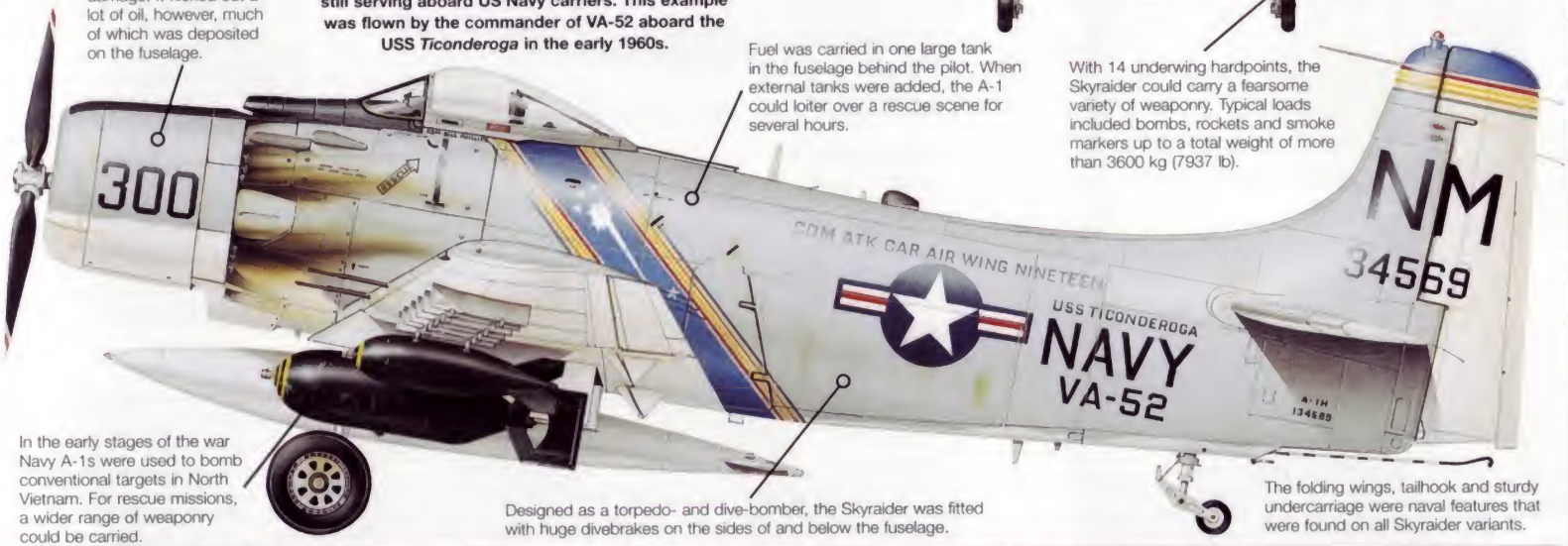
A-1H Skyraider

At the beginning of the Vietnam War the A-1 was still serving aboard US Navy carriers. This example was flown by the commander of VA-52 aboard the USS *Ticonderoga* in the early 1960s.

The 18-cylinder Wright R-3350 engine could survive serious battle damage. It kicked out a lot of oil, however, much of which was deposited on the fuselage.

Fuel was carried in one large tank in the fuselage behind the pilot. When external tanks were added, the A-1 could loiter over a rescue scene for several hours.

With 14 underwing hardpoints, the Skyraider could carry a fearsome variety of weaponry. Typical loads included bombs, rockets and smoke markers up to a total weight of more than 3600 kg (7937 lb).



In the early stages of the war Navy A-1s were used to bomb conventional targets in North Vietnam. For rescue missions, a wider range of weaponry could be carried.

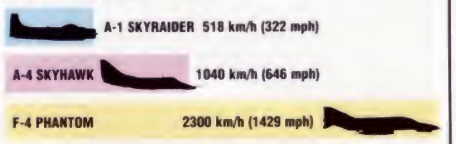
Designed as a torpedo- and dive-bomber, the Skyraider was fitted with huge divebrakes on the sides of and below the fuselage.

The folding wings, tailhook and sturdy undercarriage were naval features that were found on all Skyraider variants.

COMBAT DATA

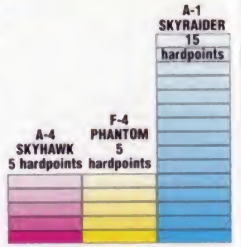
MAXIMUM SPEED

The Skyraider was a World War II aircraft, and in terms of pure speed was no match for the jet-powered A-4 of the early 1950s, let alone the sheer Mach 2 power of the Phantom II of 1960. But speed is not everything in combat, and the A-1 had virtues the other two classic fighters lacked.



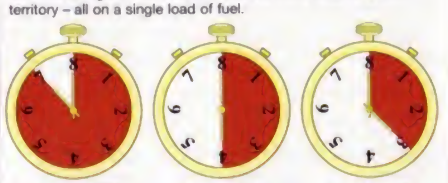
MISSION FLEXIBILITY

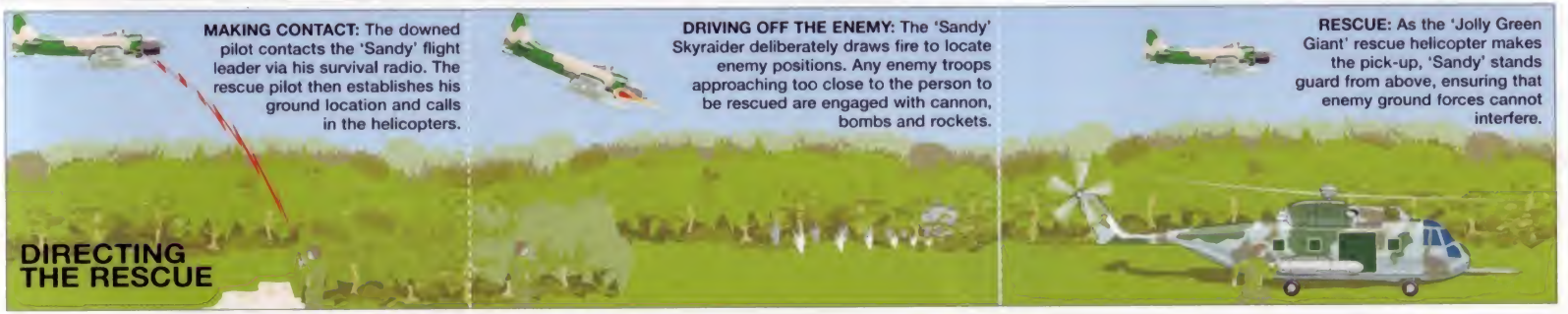
The Skyraider may not have been able to carry as much weight of ordnance as the more powerful jets, but with 14 hardpoints under the wings and one under the fuselage it could carry and deliver a greater variety of weapons on a single mission than almost any other fighting plane giving the A-1 the flexibility to fly different missions.



LOITER TIME

Compared to a jet, piston engines are extremely economical. The Skyraider might have been slow, but it could fly out to a rescue site, call in some fast jets to make an attack, direct the rescue helicopters to make the pick-up while the jets refuelled, call in the fast movers again, then escort the whole force clear of enemy territory – all on a single load of fuel.





ENGLISH ELECTRIC

CANBERRA (BOMBER)

● High-altitude bomber ● Low-level interdictor and nuclear strike

▲ *The interdictor Canberra B(I).Mk 8 and its export variants had a fighter-style canopy offset on the port side of the fuselage for the single pilot, while the navigator sat in the nose.*

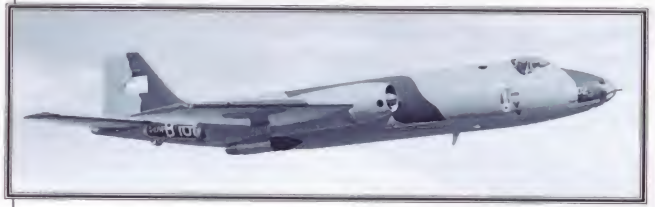
The English Electric (BAC) Canberra is one of the greatest aircraft of all time, although its short-span wings and a seemingly ordinary shape attracted little attention when it appeared in 1949. Like the de Havilland Mosquito of World War II, the Canberra was expected to fly fast and high enough to dispense with any need for defensive armament. Most Canberras were bombers or interdictors, although there were also reconnaissance and trainer versions.

PHOTO FILE

ENGLISH ELECTRIC CANBERRA

▲ **Backbone of Bomber Command**
The Canberra was the mainstay of the RAF's bomber fleet until the V-bombers entered service, taking over the strategic nuclear bombing role. These B.Mk 6s are from No. 9 Squadron.

▲ **Accurate bomber**
Canberras relied on ground stations for precise navigation and blind bombing. The bombardier had a glazed nose position for accurately aiming the bombs.



▲ **Falklands War**
It was Argentina rather than the RAF that used the Canberra in the Falklands War. One aircraft was shot down by Sea Harriers.

External bombs ▶
Regular bomber Canberras carried their bombs internally, but the interdictors, such as this B(I).Mk 6, used wing pylons.

◀ **Vietnam warrior**
Canberras were employed in many conflicts, including the Vietnam War, where the Royal Australian Air Force used the type alongside USAF aircraft on bombing raids. Note the wingtip bomb pylons.

FACTS AND FIGURES

- Out of 1352 production Canberras, 403 were built in the USA and 48 in Australia.
- The prototype Canberra (VN799) was flown for the first time on 13 May 1949 by Wing Commander Roland P. Beamont.
- Shorts developed and built the dedicated reconnaissance Canberra PR.Mk 9.
- The Martin B-57 Canberra was the first USAF jet bomber to drop a bomb in anger, in Vietnam in 1965.
- India was the biggest overseas customer, purchasing 71 Canberra intruders.
- RAF Canberras bombed Egyptian airfields during the Suez Crisis in 1956.

PROFILE

Britain's versatile bomber

Designed by W.E.W. 'Teddy' Petter and placed into Royal Air Force service in 1951, the Canberra began life as a modest technical advance, but almost immediately established a dominant position as the world's leading light bomber. Nothing else matched it: the Canberra could fly as fast as contemporary fighters and was just as agile. It could also carry a reasonable bombload to hit a target 1500 km (932 miles) away with uncanny accuracy, and bring its crew safely home.

Canberras flew with several engine types and in dozens of different roles. It was perfect for reconnaissance, both the ordinary photographic kind and the darker, more secret electronic ferreting missions of the Cold War. Other Canberras excelled as trainers and test ships. The Americans purchased the plane as the Martin B-57, and many other nations have flown the type in its four decades of service.

A Canberra powered by Bristol Olympus turbojets set a world altitude record of 20,079 m (65,876 ft) in August 1955, then reached 21,336 m (70,000 ft) two years later. In every area of performance, the Canberra was a superstar.

Above: The interdictor B(I).Mk 8 version could carry a belly pack of four ADEN cannon for strafing. Its main role, however, was as a tactical nuclear bomber.

Below: Peru bought both new and second-hand Canberras. It is the last operator of the type in the bomber role, and has used the aircraft during border clashes with Ecuador.

Canberra B.Mk 6

Type: light bomber, with electronic, photo-reconnaissance and target-tug derivatives

Powerplant: two 33.36-kN (7,503-lb-thrust) Rolls-Royce Avon Mk 109 turbojet engines

Maximum speed: 871 km/h (541 mph) at 12,190 m (39,993 ft)

Range: 5842 km (3630 miles)

Service ceiling: 14,630 m (48,000 ft)

Weights: empty 10,099 kg (22,264 lb); normal take-off 19,597 kg (43,204 lb); maximum take-off 24,041 kg (78,875 lb)

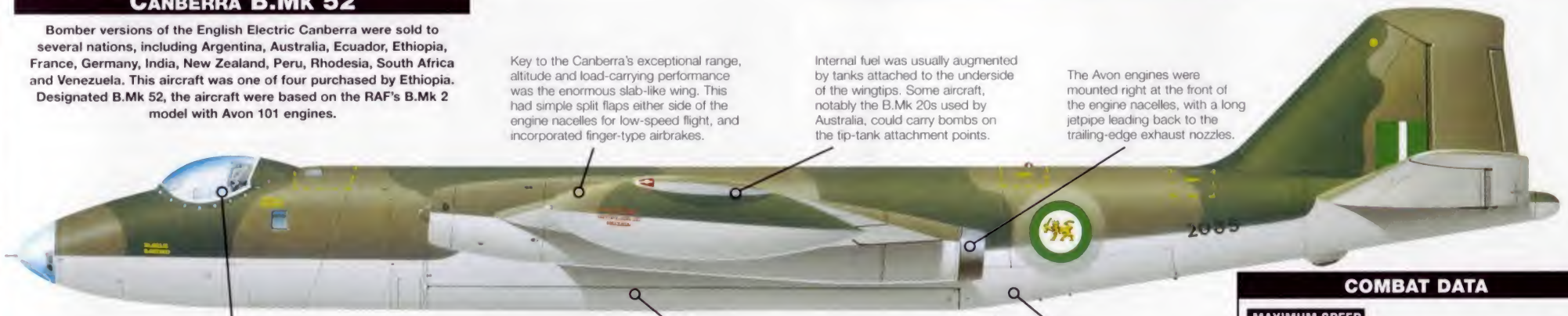
Armament: up to nine internal 454-kg (1,000-lb) bombs or other ordnance loads; two wing-mounted 454-kg (1,000-lb) bombs, gun pods, AS.30 or Martel missiles, or rocket launchers

Dimensions:

span (without wing-tip tanks)	19.51 m (64 ft)
length	19.96 m (65 ft 6 in)
height	4.75 m (15 ft 7 in)
wing area	89.19 m² (960 sq ft)

Canberra B.Mk 52

Bomber versions of the English Electric Canberra were sold to several nations, including Argentina, Australia, Ecuador, Ethiopia, France, Germany, India, New Zealand, Peru, Rhodesia, South Africa and Venezuela. This aircraft was one of four purchased by Ethiopia. Designated B.Mk 52, the aircraft were based on the RAF's B.Mk 2 model with Avon 101 engines.



Key to the Canberra's exceptional range, altitude and load-carrying performance was the enormous slab-like wing. This had simple split flaps either side of the engine nacelles for low-speed flight, and incorporated finger-type airbrakes.

Internal fuel was usually augmented by tanks attached to the underside of the wingtips. Some aircraft, notably the B.Mk 20s used by Australia, could carry bombs on the tip-tank attachment points.

The Avon engines were mounted right at the front of the engine nacelles, with a long jetpipe leading back to the trailing-edge exhaust nozzles.

The Canberra was flown by a crew of three, comprising a single pilot on the flight deck and a navigator and bombardier sitting in the fuselage below and behind him. The bombardier could crawl past the pilot's seat to a prone position in the nose for visual bomb aiming.

The entire lower half of the central fuselage was available for the carriage of bombs. The standard maximum load was nine 454-kg (1,000-lb) weapons, held in three triplets. The area above the weapons bay was used to house the bulk of the aircraft's fuel load.

In the rear fuselage, just aft of the bomb-bay, was a camera pointing vertically downwards. This was used to record the bomb drop.

Canberra B(I).Mk 8: nuclear strike

1 LOW LEVEL: The B(I).Mk 8s were based in Germany in support of NATO. Throughout the 1960s the only way to get anywhere near their WarPac targets was by flying low under the radar.

2 POP-UP: As the Canberra approached its target, it would pop up to a few hundred feet for the final run-in.

3 LAY-DOWN: The US-made Mk 43 tactical nuclear weapon was delivered in a low-level pass directly across the target.

4 PARA-RETARD: The bomb contained a braking parachute, which allowed the Canberra to escape before the nuclear explosion.

COMBAT DATA

MAXIMUM SPEED

In terms of speed and bombload the Canberra was a match for its two main rivals in Europe, the French Vautour IIB and the Russian Il-28. What the figures do not show is the extraordinary advantage it enjoyed in operational altitude.

WEAPONS

The Canberra had a useful conventional bombload, but in Germany and Cyprus its main weapon was the tactical nuclear bomb: US-made Mk 43s in Germany and British-developed 'Red Beards' in the Mediterranean.

ENGLISH ELECTRIC

LIGHTNING

● Mach 2 interceptor ● Superfast climber ● Point defender

▲ *Blistering performance and a single seat are the stuff fighter pilots dream of, and performance was what the Lightning offered in plenty. Even in its old age, to fly the beefy twin jet was the most sought-after posting in the Royal Air Force.*

Flying the English Electric Lightning was like being saddled to a skyrocket. This great interceptor, with its sharply swept-back wings and tail, guarded Britain against air attack for many years. The Lightning was a creature of raw power and brute force – it had the incredible ability to climb to 10,000 m (32,808 ft) in two minutes – and was regarded with great affection by pilots who flew it.

PHOTO FILE

ENGLISH ELECTRIC LIGHTNING

◀ **Rapid reaction**
The Lightning was a very fast-reacting interceptor. Even as the big jet reached old age in the 1990s, only fighters such as the F-15 and Su-27 could match its superb climb performance.

▲ **Overwing tanks**
A unique feature of the Lightning was the use of overwing fuel tanks. They were often carried to extend the aircraft's meagre range.

▼ **Export Lightnings**
Kuwait and Saudi Arabia were the Lightning's only export customers. The two Gulf air forces used its intercept capability to defend their desert airspace.

▲ **Two-seat trainer**
The Lightning was quite a handful to fly. To familiarize pilots with its tricks, a wide-nosed two-seat trainer was developed, housing student and instructor side by side.

◀ **Supersonic prototype**
This is the English Electric P.1A – forerunner of the Lightning. Distinguished by its rounded-triangle intake, lack of radar and short fin, the type's sharply swept wings were then unique.

FACTS AND FIGURES

- The prototype P.1A made its first flight on 4 August 1954.
- A small test aircraft was used to evaluate the Lightning's wing configuration.
- The P.1B Lightning prototype was the first British fighter to fly at twice the speed of sound, on 25 November 1958.
- In all, 337 Lightnings were manufactured, including test craft and export models for Kuwait and Saudi Arabia.
- Improved Lightning variants were planned but never built.
- The Lightning was the last all-British supersonic fighter.

PROFILE

Britain's front line

The Lightning was aptly named indeed. This classic fighter really was a bolt out of the blue, able to hurtle skywards at enormous speed to confront any intruder.

During the Cold War, Lightning pilots frequently turned back Soviet reconnaissance aircraft heading for Britain's shores; in a real shooting war, this swift flying machine would have detected, intercepted and fired its Firestreak or Red Top missiles on approaching bombers and cruise missiles, sending many falling in flames.

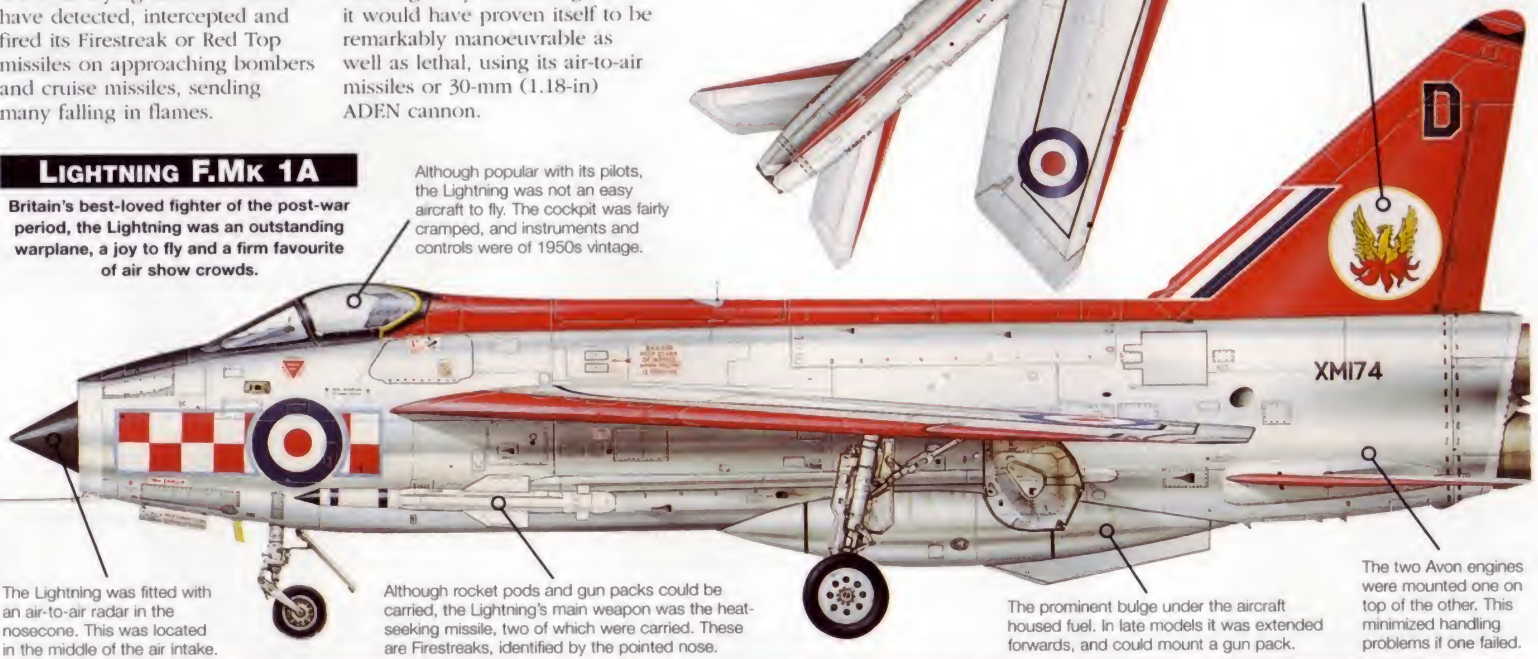
From the cockpit, this was a racehorse of the skies. Few other fighters were as fast or as formidable. Pilots cherished the Lightning; although not easy to handle at low speed near the airfield and hampered by limited visibility, the Lightning's quirks were easy to 'learn' and it was a sensational performer once aloft.

Had the Lightning been challenged by another fighter, it would have proven itself to be remarkably manoeuvrable as well as lethal, using its air-to-air missiles or 30-mm (1.18-in) ADEN cannon.

A Vulcan leads a quartet of Lightnings, encapsulating British air power in the 1960s.

LIGHTNING F.MK 1A

Britain's best-loved fighter of the post-war period, the Lightning was an outstanding warplane, a joy to fly and a firm favourite of air show crowds.



Built for speed, the Lightning featured a wing of incredible sweepback. Later models had a small kink added to improve handling.

RAF squadrons in the 1960s were renowned for applying colourful markings to their aircraft. No. 56 Squadron, known as the 'Firebirds', featured its traditional Phoenix badge and red/white chequerboard on its Lightnings.

Although popular with its pilots, the Lightning was not an easy aircraft to fly. The cockpit was fairly cramped, and instruments and controls were of 1950s vintage.

The Lightning was fitted with an air-to-air radar in the nosecone. This was located in the middle of the air intake.

Although rocket pods and gun packs could be carried, the Lightning's main weapon was the heat-seeking missile, two of which were carried. These are Firestreaks, identified by the pointed nose.

The prominent bulge under the aircraft housed fuel. In late models it was extended forwards, and could mount a gun pack.

The two Avon engines were mounted one on top of the other. This minimized handling problems if one failed.

Lightning F.Mk 6

Type: single-seat air-defence fighter

Powerplant: two 72.77-kN (16,367-lb-thrust) Rolls-Royce Avon 302 afterburning turbojets

Maximum speed: Mach 2.3 or 2415 km/h (1,500 mph) at 12,000 m

Range: 1200 km (746 miles)

Service ceiling: 16,500 m (54,134 ft)

Weights: empty 12,700 kg (28,000 lb); loaded 22,500 kg (73,820 lb)

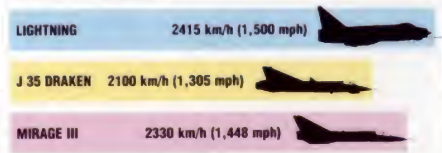
Armament: two ADEN 30-mm (1.18-in) cannon with 120 rounds each; two Red Top or Firestreak heat-seeking missiles; 2500 kg (5,512 lb) of under- and over-wing stores (export variants only)

Dimensions:

span	10.62 m (34 ft 10 in)
length	16.84 m (55 ft 3 in)
height	5.97 m (19 ft 7 in)
wing area	35.31 m² (380 sq ft)

COMBAT DATA

MAXIMUM SPEED



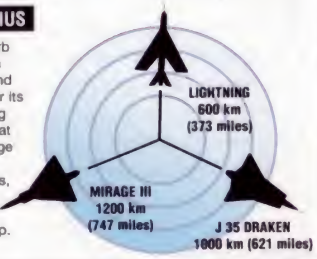
Mach 2.5 is about the limit at which an aircraft can fly without being built from exotic – and very expensive – materials. As a result, fighters which entered service in the late 1950s are just as fast as aircraft built three decades later.

CLIMB RATE

The Lightning was designed to intercept high-flying bombers. Its immense power gave it a phenomenal climb rate, which can be matched only by superfighters such as the American F-15 Eagle and the Russian Sukhoi Su-27 'Flanker'. Used for point defence the Lightning could reach incoming bombers within minutes of take-off.

COMBAT RADIUS

To get such superb performance from what was a big and heavy machine for its time, the Lightning used fuel at a great rate. Its short range was fine for interception duties, but for longer missions could be a real handicap.



Mach 2 Pioneers

■ **SAAB J 35 DRAKEN:** This Swedish contemporary of the Lightning was just as startling in its own way. Its most distinguishing feature was its unique double-delta wings.

■ **LOCKHEED F-104 STARFIGHTER:** Like the Lightning, the F-104 was designed as a fast-climbing high-speed interceptor. It was a smaller and less powerful machine.

■ **DASSAULT MIRAGE III:** The delta-winged Mirage was Europe's first Mach 2 service jet. Much lighter than the Lightning, it was a great export success.

■ **MiG-21:** Entering service in 1957, the MiG-21 was a mainstay of Soviet aviation. Exported to many countries, it has been built in larger numbers than any other supersonic fighter.

ENGLISH ELECTRIC

CANBERRA PR

● Long-range reconnaissance ● Secret spy flights? ● Still in service

In 2001 the RAF celebrated the 50th anniversary of continuous Canberra service, such is the continued viability of the type as a proven and adaptable reconnaissance platform. Like the wartime de Havilland Mosquito which it replaced, the Canberra has admirably filled both bomber and photo-reconnaissance roles for the RAF and foreign air forces alike. It is in the latter role, however, that the type has proved indispensable.

▲ *Like other intelligence assets, much of the operational life of the RAF's Canberra reconnaissance fleet has been shrouded in secrecy. A small fleet remains in use after more than 50 years, a testimony to its continuing usefulness.*

PHOTO FILE

ENGLISH ELECTRIC CANBERRA PR

▲ PR.Mk 7 from B.Mk 6
Derived from the B.Mk 6 bomber variant, the PR.Mk 7 was distinguished by its unusual glazed nose, which lacked the bomb aimer's optically flat panel. The silver finish was later replaced with camouflage, which in turn gave way to low-visibility hemp.

▲ 21st-century upgrade
The RAF's surviving Mk 9s have been upgraded to include a long-range oblique photography (LOROP) camera.

Canberra conversion ▶
For conversion training, the RAF uses a few T.Mk 4s and PR.Mk 7s.

▲ Extra fuel tanks
Like Canberra bomber versions, PR.Mk 3s and 7s were able to carry two wingtip-mounted fuel tanks, each able to hold 1137 litres (300 US gallons).

PR.Mk 9 prototype ▶
Displaying its redesigned wings, WH793 was the first PR.Mk 9. Converted from a PR.Mk 7, it retained the earlier mark's cockpit.

FACTS AND FIGURES

- Canberra PR.Mk 3, WE139, now at the RAF Museum, won the speed section of the 1953 London – New Zealand Air Race.
- In late 1996 an RAF PR.Mk 9 was used to locate Rwandan refugees in Zaire.
- RAF PR.Mk 9s operate alongside Tornado GR.Mk 1As in the reconnaissance role.
- By 1996 Chile's last two PR.Mk 9s were believed grounded; India was still operating six PR.Mk 57s.
- In peacetime, RAF Canberras are used to map military installations and ranges.
- In 1996 No. 39 Squadron began the mapping of Kenya using PR.Mk 9s.

PROFILE

Long-serving camera ship

By the time Mosquito PR.Mk 34s and 35s were retired in the early 1950s, the RAF had chosen to develop a reconnaissance version of the Canberra light bomber under Specification PR.31/46. Thus the Canberra PR.Mk 3 prototype flew on 19 March 1950. Based on the B.Mk 2 bomber, the Mk 3 was stretched 35.5 cm (14 in) in order to accommodate extra fuel tanks and camera equipment. Thirty-five examples were built for the RAF and were followed by 74 PR.Mk 7s, derived from the longer-range B.Mk 6 and first flown in 1953.

It is alleged that an RAF PR.Mk 7 made a high-altitude flight over the Soviet Union in 1954 to obtain vital targeting information for the RAF's nuclear V-Force bombers.

New, longer-span wings and more powerful Avon engines on the PR.Mk 9 greatly improved altitude performance. This variant entered service in 1960, serving the RAF in Germany, Cyprus, Malta and Singapore. During the 1962 Cuban missile crisis RAF PR.Mk 9s tracked Soviet shipping movements. Most recently the RAF's last five Mk 9s have made intelligence-gathering flights over Bosnia. Canberra PRs have been exported to India, Venezuela and, finally, to Chile.

Above: This PR.Mk 7 was captured on film en route to an exercise in Sicily, Italy. The RAF's No. 1 PRU retains two Mk 7s for training, while India continues to use a few PR.Mk 57s.

Above: Signifying the unit's early history as a bomber squadron, the 'winged bomb' tail-fin badge on this Mk 9 is that of No. 39 Squadron, RAF. This aircraft is today preserved as a gate guard at RAF Wyton.

Canberra PR.Mk 9

Type: high-altitude, long-range photographic reconnaissance aircraft

Powerplant: two 50-kN (11,246-lb-thrust) Rolls-Royce Avon Mk 206 turbojets

Maximum speed: 900 km/h (559 miles) at 12,192 m (40,000 ft)

Initial climb rate: 3660 m/min (12,008 fpm)

Range: 8160 km (5,070 miles)

Service ceiling: over 18,300 m (66,039 ft) (maximum operational altitude over 21,000 m/69,000 ft)

Weights: empty about 13,608 kg (30,000 lb); maximum take-off 26,081 kg (57,500 lb)

Dimensions:

span	20.68 m (67 ft 10 in)
length	20.32 m (66 ft 8 in)
height	4.75 m (15 ft 7 in)
wing area	97.08 m² (1,045 sq ft)

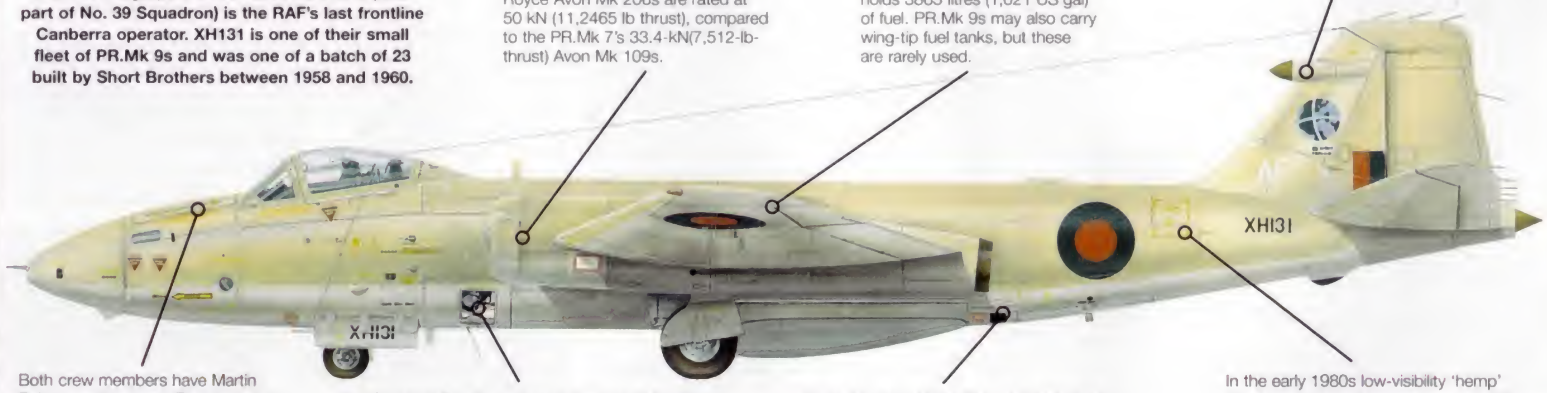
CANBERRA PR.MK 9

No. 1 Photographic Reconnaissance Unit (now part of No. 39 Squadron) is the RAF's last frontline Canberra operator. XH131 is one of their small fleet of PR.Mk 9s and was one of a batch of 23 built by Short Brothers between 1958 and 1960.

All Canberras were powered by Rolls-Royce's ever-reliable Avon turbojets. PR.Mk 9s are the most powerful Canberras built. Their Rolls-Royce Avon Mk 206s are rated at 50 kN (11,2465 lb thrust), compared to the PR.Mk 7's 33.4-kN(7,512-lb-thrust) Avon Mk 109s.

A distinctive feature of the Mk 9's longer span wing is the increased chord inboard of the engines. An integral fuel tank in each wing holds 3865 litres (1,021 US gal) of fuel. PR.Mk 9s may also carry wing-tip fuel tanks, but these are rarely used.

As part of the continued upgrading of the surviving PR.Mk 9s, a radar warning receiver (RWR) was fitted in fin- and tail-mounted fairings to provide visual and audible alert of the presence of illuminating radars.



Both crew members have Martin Baker ejection seats. The navigator occupies a compartment forward of the cockpit, his seat blasting through a frangible hatch above.

Among the various sensors fitted is the port-facing F.96 oblique camera, mounted behind optically flat glass and equipped with either a 61-cm (24-in) or 122-cm (48-in) lens.

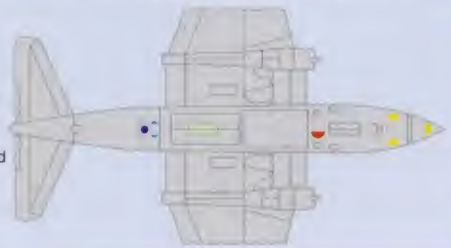
In place of a weapons bay reconnaissance Canberras have a camera bay in which various types of camera and infra-red linescan equipment are installed.

In the early 1980s low-visibility 'hemp' colours were introduced on several RAF aircraft types, including the reconnaissance Canberras, Nimrod maritime patrol aircraft and Victor and VC 10 in-flight refuellers.

Canberra's cameras

SPECIALISED CAMERA FIT: Fitted with cameras optimized for tactical reconnaissance, the RAF's Canberra PR.Mk 9s are used largely for daytime survey work fitted with a variety of cameras with varying focal length lenses. For night/all-weather work, an infra-red (IR) linescan unit is used to see targets obscured by cloud, showing relative temperatures of objects in the target area. The IR linescan equipment used by the Canberras came from retired Phantom FGR.Mk 2s.

TACTICAL RECONNAISSANCE/SURVEY



KEY:

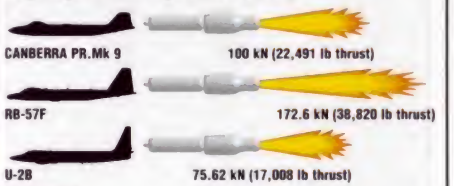
- 3 x F.95 cameras
- 1 x F.96 port-facing oblique wide-angle format camera
- 1 x F.49 Mk 4 survey camera
- 2 x F.96 cameras with long focal length lenses
- 1 x F.96 vertical camera with short focal length lens
- 1 x IR linescan unit

NIGHT/ALL-WEATHER RECONNAISSANCE

ACTION DATA

THRUST

Martin's RB-57F was a radical development of the Canberra designed to operate at higher altitudes. As well as new long-span wings, larger turbofan engines were installed.

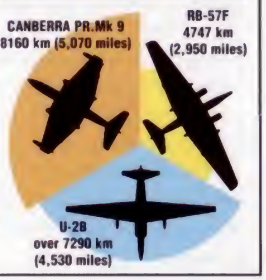


CEILING

Early versions of Lockheed's U-2 spy plane could operate at altitudes above 24 km (78,740 ft), well above the Canberra and RB-57F. Altitude gives spy aircraft a margin for safety on hazardous missions.

RANGE

Canberra PR.Mk 9s, with their increased fuel tankage, have a prodigious range performance, similar to that of early U-2s. Though able to operate at high altitudes, the RB-57F was hampered by poor range. Long range allows an intelligence-gathering aircraft to make positioning flights far from home bases and carry out missions deep into hostile territory.



FAIRCHILD

A-10 THUNDERBOLT II

● Tank-buster supreme ● Close air support ● Forward air control

Friendly troops are about to be crushed into the dirt by enemy tanks. Suddenly, help appears. Over the battlefield roar Fairchild A-10 Thunderbolt II anti-tank warplanes, known to everybody as 'Warthogs'. Within minutes, the A-10s unleash a withering barrage of gunfire and a hail of missiles, leaving the tanks a twisted mass of smoking steel and halting the enemy in his tracks.

▲ *The A-10 showed its worth in the First Gulf War, when 'experts' had written it off as good only for forward air control. Flying under ideal conditions, the 'Warthog' ripped through Iraq's armour with deadly efficiency.*

PHOTO FILE

FAIRCHILD A-10 THUNDERBOLT II

▲ Two-seater

A single two-seat night and adverse weather A-10B was built for evaluation, but was not followed up. The A-10 remains a fair weather machine, with relatively simple avionics and no attack radar.

▲ The flying gun ▼

The A-10 was built around the awesome GAU-8 Avenger 30-mm (1.18-in) cannon. Firing 30-round bursts of depleted uranium shells at up to 4200 rounds per minute, it is the most powerful gun ever fitted to a combat aircraft.

▲ Friendly fire

Two British Army Warrior personnel carriers were blasted by Mavericks from A-10s in a Gulf War 'friendly fire' incident. This highlighted the importance of forward air controllers.

▲ Fully loaded

In addition to its mighty gun, the A-10 can carry a wide range of air-to-ground weapons, of which the AGM-65 Maverick is the most important.

Gulf tank-killer ▶

Some 200 A-10s of the 23rd and 354th Tactical Fighter Wings were sent to the Gulf, second only to the F-16 in terms of numbers deployed.

FACTS AND FIGURES

- In its primary role the A-10 smashed more than 1000 Iraqi tanks, 1200 guns and 2000 military vehicles in the Gulf.
- Nearly 200 A-10s were sent to the Gulf, and equipped three fighter wings.
- A-10s flew more than 8500 combat sorties during Operation Desert Storm.
- The A-10's seven-barrel GAU-8 cannon is the most powerful gun ever carried by a tactical aircraft.
- The GAU-8 cannon can destroy any known main battle tank.
- OA-10s were used to control other fighters on 'Fast FAC' missions.

PROFILE

Warthog goes tank-busting

During the 1991 Gulf War, the slow, ugly but nimble A-10 proved itself a devastating weapon against the tanks of Iraq's Republican Guard. Second only to the F-16 in the numbers of aircraft deployed to Saudi Arabia, the 'Warthog' ranged the deserts of Kuwait and Iraq, using its devastating GAU-8 gun and pinpoint-accurate Maverick missiles to smash tanks, artillery pieces, military vehicles, radar sites and missile launchers.

They even downed two helicopters, scoring the only gun-kills of the air war.

Some idea of the A-10's worth can be gained from the performance of just two pilots. Captain Eric Solomonson and Lieutenant John Marks of the USAF's 23rd Tactical Fighter Wing accounted for 23 Iraqi tanks in a single day. Altogether, Warthog pilots destroyed more than 4500 tanks, vehicles and artillery pieces in the course of the war. There were those who had claimed the A-10 was too slow for the modern battlefield, but the war against Saddam showed that, although other jets fly higher and faster, nothing could match the Warthog for destroying tanks on the ground.

The Vietnam War demonstrated just how unsuitable for strike missions some US fighters were. Consequently, the A-10 was designed with its armament and defence measures as a priority.

The A-10 is a clear-weather aircraft with no combat radar.

Vital parts of the A-10's airframe are armoured and can withstand hits from 23-mm (0.91-in) cannon shells.

An ALQ-184 ECM pod, designed to jam enemy gun and missile radars, is carried for self-defence.

A-10A Thunderbolt II

Type: single-seat anti-tank aircraft

Powerplant: two 40.31-kN (9,066-lb-thrust) General Electric TF34-GE-100 non-afterburning turbofans

Maximum speed: 682 km/h (424 mph)

Ferry range: 4000 km (2,485 miles)

Service ceiling: 10,575 m (34,695 ft)

Weights: empty 10,977 kg (24,200 lb); loaded 21,500 kg (47,400 lb)

Armament: one General Electric GAU-8/A 30-mm (1.18-in) cannon with 1350 rounds plus up to 7258 kg (16,000 lb) of mixed ordnance including laser-guided bombs, cluster bombs and AGM-65 Maverick missiles on 11 weapons pylons

Dimensions:

span	17.53 m (57 ft 6 in)
length	16.25 m (53 ft 4 in)
height	4.47 m (14 ft 8 in)
wing area	47.01 m² (506 sq ft)

OA-10A Thunderbolt II

Although most of the A-10s deployed to the Gulf were 'shooters', the 23rd Tactical Air Support Squadron based at King Fahd Airport flew OA-10As as Forward Air Controllers.

The high-set bubble canopy gives the A-10 a superb view of the battlefield, while a titanium armour 'bathtub' protects the pilot from ground fire.

The controls are linked to traditional cables as well as hydraulics for an emergency back-up in case of damage.

Pave Penny is a laser tracker system mounted under the nose. It detects reflected laser energy from designated targets.

Although Sidewinder missiles are carried for self-defence, the only weapons used on the FAC mission are rockets, which mark targets for other attack aircraft.

The A-10's controls are linked to traditional cables as well as hydraulics for an emergency back-up in case of damage.

The TF-34 engines are high-mounted for avoiding debris when using tactical airstrips. They have a relatively low infra-red signature and are powerful enough for the A-10 to fly on one engine.

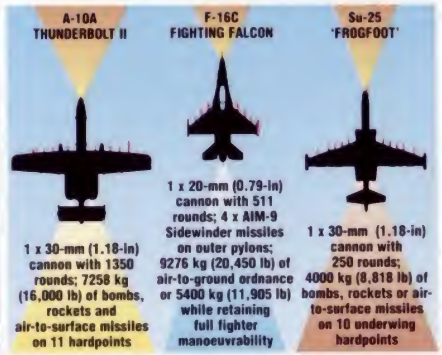
The undercarriage retracts into nacelles in the leading edge of the wing. The wheels are slightly exposed, so that the A-10 can better survive a belly landing.

The twin fins look archaic, but they help screen jet heat signature, and as the A-10 can fly with one fin shot away they also give a damaged aircraft more chance of getting home.

COMBAT DATA

WEAPONS LOAD

Slower than its Soviet equivalent, the Su-25 'Frogfoot', the A-10 has a heavier weapons load. Both are extremely versatile and carry a wide variety of weaponry on multiple stores stations beneath the wings and fuselage. However, the A-10 has been replaced in front-line service by the F-16, which is much faster, more agile, and carries a heavier weapons load.



The Avenger cannon in action

GUN ENGAGEMENT: A-10s usually engage enemy armour with their guns from a shallow dive. The GAU-8 is effective against ground targets at ranges of up to 3 km (2 miles).

BURST FIRE: The A-10 pilot can select between 2100 and 4200 rounds per minute. At high rate, a typical 30-round burst lasts less than half a second.

ARMOUR PIERCING: The depleted (non-radioactive) uranium armour-piercing shells weigh around 500 g (18 oz), and have a secondary incendiary effect.

MULTI-BARREL CANNON: The GAU-8 Avenger is a seven-barrel electrically driven Gatling-type gun.

AMMUNITION DRUM: The massive reload drum contains up to 1350 rounds the size of beer bottles.

AMMUNITION LOAD: A typical load contains armour-piercing and high-explosive incendiary rounds.

MISSILE LOAD: In spite of the immense power of its cannon, the A-10's primary anti-armour weapon is the infra-red-guided Maverick missile, which has a range of between 25 and 40 km (15 and 25 miles).

GENERAL DYNAMICS

FB-111A

● Two-seat 'swing-wing' bomber ● Nuclear weapons delivery

▲ *The key to the FB-111's range, speed and heavy lift capacity was the aircraft's variable geometry 'swing wings'. These are unswept during take-off and landing, then swept back for high speed.*

A bold attempt to combine the roles of fighter and strike bomber in an aircraft that would be equally at home on a carrier deck or a land base, the F-111 took some years to develop into a first-line combat aircraft. In the 1970s, General Dynamics began an updating program that kept the F-111 current through the last years of the Cold War. The FB-111A nuclear bomber was developed for Strategic Air Command – just in case.

PHOTO FILE

GENERAL DYNAMICS FB-111A

▲ Weapons bay
The internal weapons bay could be used for either extra fuel or short-range nuclear missiles.

▲ Two crew members
The crew consisted of a pilot and weapons systems officer, the latter was responsible for navigation and weapon delivery.

▼ Afterburners for speed
Two Pratt & Whitney TF30 afterburning turbofans provided power for high speed.

▲ 'Aardvark' and 'Earth Pig'
Its ungainly appearance on the ground has earned the F/FB-111 at least two nicknames.

Huge load capacity ▶
Each wing on the FB-111 could be fitted with up to four pylons for carrying weapons or fuel up to a maximum weight of 16,973 kg (37,420 lb). Bombs would usually be carried on the inner pylons.

FACTS AND FIGURES

- The aircraft uses terrain-following radar that enables it to be flown completely 'hands off'.
- The original F-111s were the first swing-wing aircraft to enter service.
- Part of the FB-111's main undercarriage door is also used as an air brake.
- Dumping unused fuel into the afterburner exhaust of an F/FB-111 results in a spectacular flame, or 'torching'.
- The prototype FB-111A was converted from the eighteenth F-111A constructed.
- The FB-111A had longer wings and stronger undercarriage than the F-111A.

PROFILE

SAC's atomic 'Aardvark'

Politics and defence budgets balanced the future of the General Dynamics F-111 on a knife edge more than once. Costly and controversial, the aircraft was shunned by foreign governments, but after two combat tours in Vietnam, its potential was recognized. General Dynamics embarked on a comprehensive upgrading, the success of which ensured that the 'Vark' remained one of the world's most potent combat aircraft.

Cancellation of Strategic Air Command's (SAC) new spearhead, the Rockwell B-1A, in the 1970s led to a potential nuclear-strike shortfall if the ageing B-52 fleet was grounded for any reason. An alternative had to be found and the FB-111A was the USAF's answer. An order for 263 of this strategic bomber version was placed.

When the B-1 was reinstated, however, the FB-111 order was reduced to 76. The first FB-111A made its maiden flight on 13 July 1968. With the end of the Cold War, the FB-111 fleet was retired, some aircraft being converted to F-111Gs armed with conventional weapons and used mainly for training. By 1993, all had been retired to cut costs, 15 being sold to Australia to supplement its F-111C fleet.

On long-range missions only one AGM-69 SRAM would have been carried; the rest of the weapons bay was taken up by an auxiliary fuel tank.

The F-111G and FB-111 shared the longer span wing for additional range. The F-111G was basically an FB-111 airframe converted for the training role. A large bombload could be carried under the wing in addition to the internal bomb-bay load.

The 76 FB-111As were converted from airframes of the F-111K aircraft originally ordered by the Royal Air Force, but later cancelled.

The F-111's weak point was its engines, the TF30 suffered ongoing reliability problems and also sometimes 'flamed out' when afterburner was engaged.

FB-111A

Type: Two-seat nuclear/conventional strike bomber

Powerplant: Two 89.81-kN (20,200-lb-thrust) Pratt & Whitney TF30-7 afterburning turbofan engines

Max speed: 2649 km/h (1,646 mph) 'clean' at 10,973 m (36,000 ft)

Service ceiling: 18,288 m (60,000 ft)

Range: more than 4700 km (2,920 miles)

Weights: empty 21,714 kg (47,872 lb); loaded 57,922 kg (127,697 lb)

Weapons: up to six AGM-69 short-range attack missiles or 16,973 kg (37,420 lb) of free-fall nuclear weapons

Dimensions:

span	21.34 m (70 ft)
length	23.16 m (76 ft)
height	5.18 m (17 ft)
wing area (spread)	51.10 m² (550 sq ft)

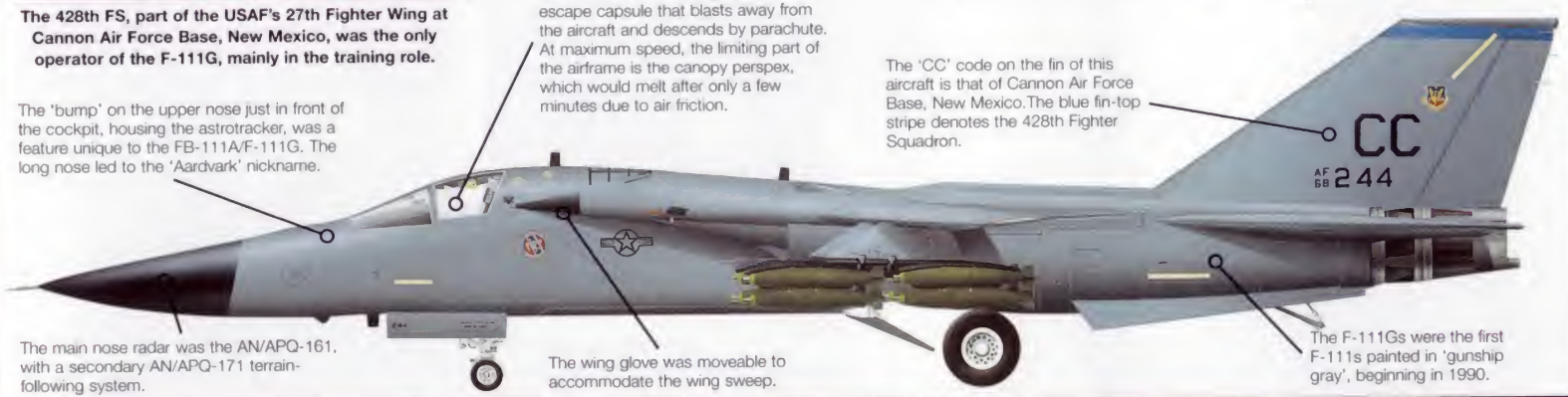
F-111G

The 428th FS, part of the USAF's 27th Fighter Wing at Cannon Air Force Base, New Mexico, was the only operator of the F-111G, mainly in the training role.

If the crew needs to eject from an FB-111, the entire cockpit becomes an escape capsule that blasts away from the aircraft and descends by parachute. At maximum speed, the limiting part of the airframe is the canopy perspex, which would melt after only a few minutes due to air friction.

The 'bump' on the upper nose just in front of the cockpit, housing the astrotracker, was a feature unique to the FB-111A/F-111G. The long nose led to the 'Aardvark' nickname.

The 'CC' code on the fin of this aircraft is that of Cannon Air Force Base, New Mexico. The blue fin-top stripe denotes the 428th Fighter Squadron.



The main nose radar was the AN/APQ-161, with a secondary AN/APQ-171 terrain-following system.

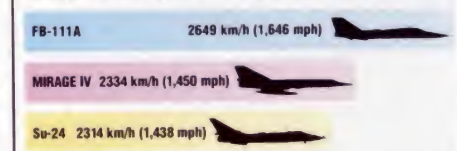
The wing glove was moveable to accommodate the wing sweep.

The F-111Gs were the first F-111s painted in 'gunship gray', beginning in 1990.

ACTION DATA

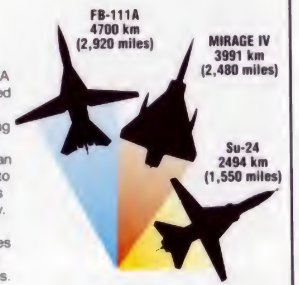
SPEED

Although the FB-111 is a heavy aircraft, its TF30 turbofans provide over 176.44 kN (39,683 lb thrust) – enough to make it one of the fastest combat aircraft ever. Bomber designs of the 1960s were based around a high penetration speed to give a better survival rate against enemy fighters and surface-to-air missiles.



RANGE

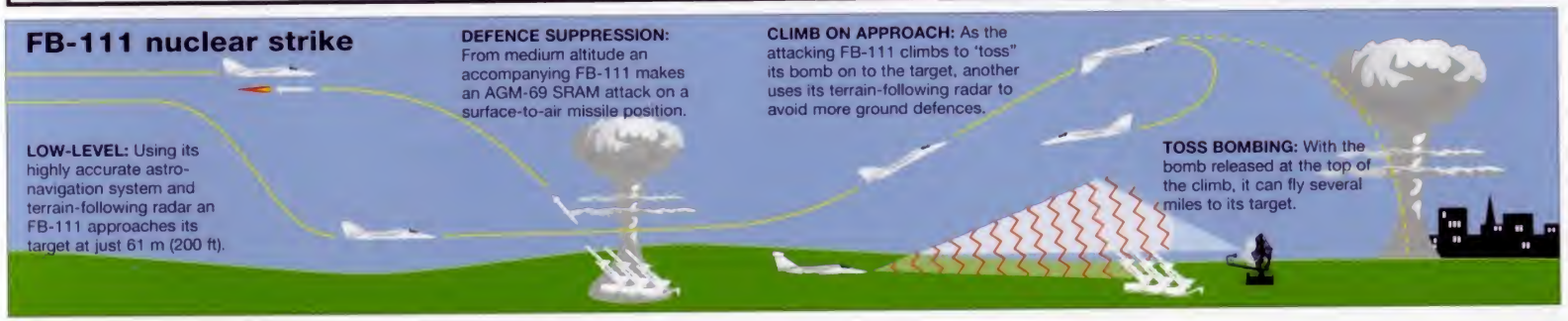
Designed for nuclear strikes against targets deep inside the Soviet Union, both the FB-111A and the Mirage IV required long range. Although powered by fuel-guzzling engines, the FB-111A could penetrate more than 2010 km (1,250 miles) into the Soviet Union thanks to its large fuel capacity. The Su-24 is a more modern design and does not require the reach of its Cold War adversaries.



WEAPONS

Again, the FB-111's size is a major factor in determining its payload. Its internal and external weapon points, along with its immensely powerful engines, give the FB-111A twice the bomb carrying capacity over the Mirage IV and the Su-24. On long-range missions, however, the FB-111A would have carried just one SRAM missile to allow extra fuel to be carried.

FB-111 nuclear strike



GLOSTER

METEOR

● RAF's first jet fighter ● Worldwide exports ● Long career

▲ *As Britain's premier immediate post-war jet fighter, the Meteor served with many regular and reserve squadrons. The aircraft also had great success on the export market and was combat tested, in Australian hands, over Korea.*

First flown in March 1943, the Meteor was the only Allied jet fighter to see action during World War II. Later versions included trainers, two-seat night fighters and both high- and low-level photo-reconnaissance types. It was also the RAF's standard interceptor of the early 1950s. More than 3500 were built for the air forces of a dozen countries, and the last night fighters were not retired from RAF service until 1961.

PHOTO FILE

GLOSTER METEOR

Ground-attack Meteor ▶
As a private venture Gloster developed a specialized variant of the Meteor, with wingtip fuel tanks and wings strengthened to carry up to 1814 kg (4,000 lb) of bombs or rockets. Only one machine was built.

▲ Meteor T.Mk 7
With the Meteor flying at speeds of up to 966 km/h (600 mph), the RAF urgently required a fighter trainer.

Target drone ▶
Meteor U.Mk 16s were converted to radio-controlled targets by modifying F.Mk 8 airframes.

▲ Topping up the tanks
Several Meteor F.Mk 4s were fitted with refuelling probes for trials with No. 245 Squadron.

Meteors for cotton ▶
Ten Meteor T.Mk 7s and 60 F.Mk 8s were delivered to Brazil in exchange for raw cotton.

FACTS AND FIGURES

- The Rover W.2B engine was to have powered the Meteor, but delays with this engine led to others being developed.
- On 5 March 1943 the first Meteor, fitted with de Havilland engines, lifted off.
- Rolls-Royce took over the W.2B engine and developed it into the Welland.
- A Meteor was sent to the USA for tests in 1944; in exchange the UK received a Bell XP-59A Airacomet.
- Meteor F.Mk Is were slower than both the Tempest Mk V and Spitfire Mk XIV.
- A total of 1090 Meteor F.Mk 8s were built for the RAF.

PROFILE

Fifty years of service

Early Meteors were powered by a number of jet engines. The 20 Mk Is had Rolls-Royce Wellands, the single Mk II used de Havilland Goblins, and most of the 280 Mk IIIs had Rolls-Royce Derwents. The Mk I's first operational task was intercepting FZG-76 flying bombs, while ground-attack Mk IIIs took part in the final Allied advance into Germany.

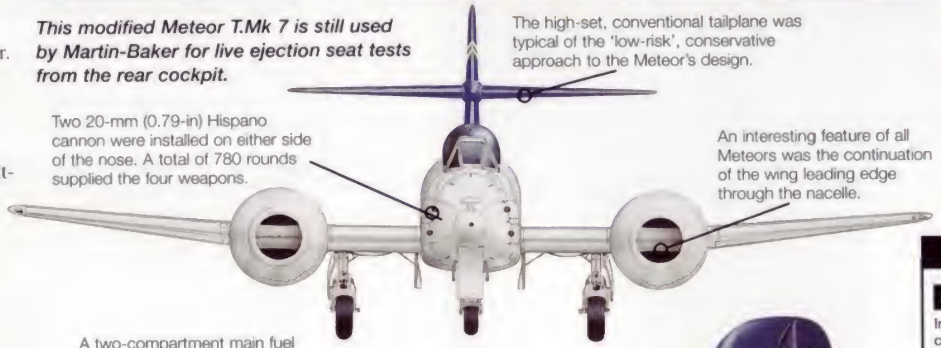
In 1945 and 1946 clipped-wing Mk IIIs set new world speed records of 975 and 991 km/h (606 and 616 mph). The F.Mk 4 retained the clipped wing, but faster fighters were already starting to appear and a major redesign was carried out to produce the F.Mk 8.

Royal Australian Air Force F.Mk 8s were used on both fighter and ground-attack missions during the Korean War. This model was also built in Belgium and the Netherlands.

There were photo-reconnaissance and trainer versions of the F.Mk 4 and night-fighter variants were built by Armstrong Whitworth.

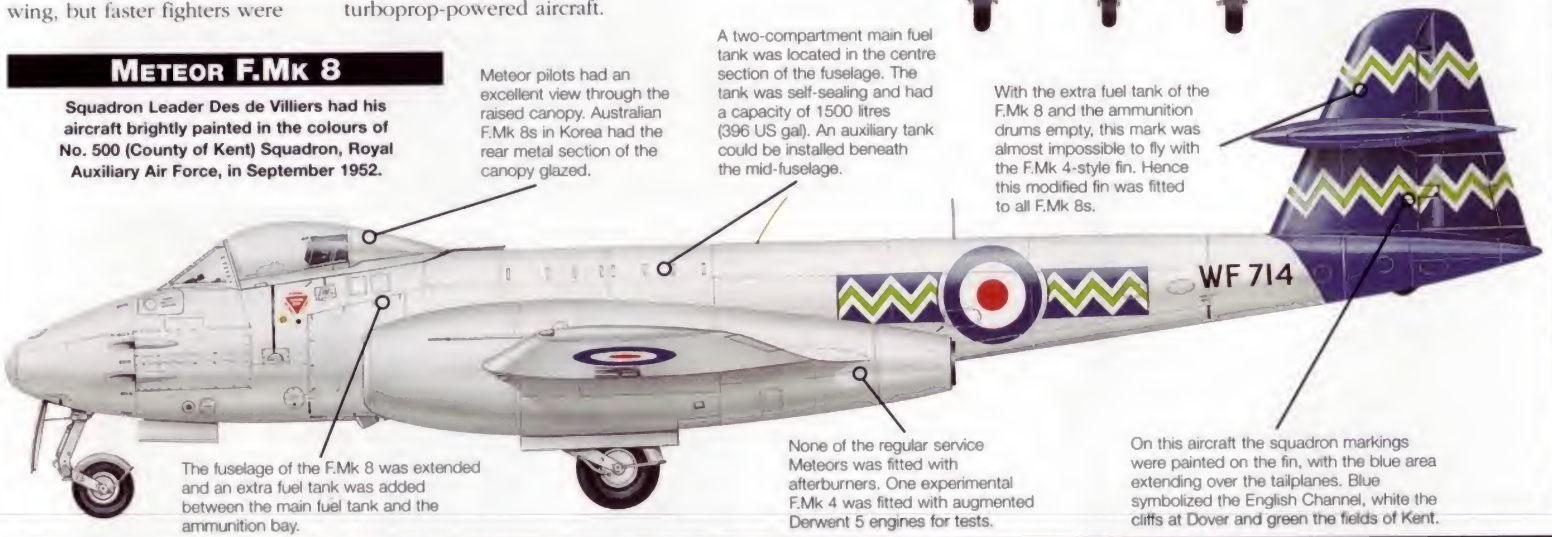
Experimental versions included an F.Mk 4 modified to serve as the world's first turboprop-powered aircraft.

This modified Meteor T.Mk 7 is still used by Martin-Baker for live ejection seat tests from the rear cockpit.



METEOR F.MK 8

Squadron Leader Des de Villiers had his aircraft brightly painted in the colours of No. 500 (County of Kent) Squadron, Royal Auxiliary Air Force, in September 1952.



Meteor F.Mk 8

Type: single-seat day-fighter

Powerplant: two 15.6-kN (3,509-lb-thrust) Rolls-Royce Derwent Series 8 turbojets

Maximum speed: 956 km/h (594 mph) at sea level

Range: 1110 km (690 miles)

Service ceiling: 13,106 m (43,000 ft)

Weights: empty 4846 kg (10,684 lb); maximum take-off 7122 kg (15,701 lb)

Armament: four 20-mm (0.79-in) cannon plus up to 16 rockets or one 454-kg (1,000-lb) bomb

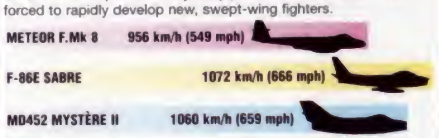
Dimensions:

span	11.28 m (37 ft)
length	13.41 m (44 ft)
height	3.96 m (13 ft)
wing area	32.85 m² (354 sq ft)

COMBAT DATA

MAXIMUM SPEED

In order to speed up service entry, the Meteor was designed conservatively with straight wings. This limited its potential speed, even when compared to very early post-war rivals. Britain was forced to rapidly develop new, swept-wing fighters.

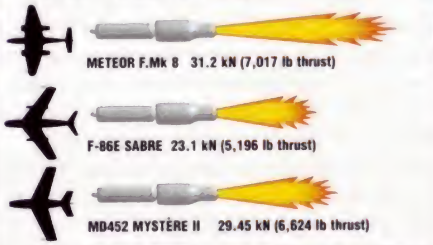


ARMAMENT

Six cannon were specified for the Meteor, but engine power was limited and only four were fitted as a weight-saving measure. The Sabre carried lighter machine guns, but was rarely seen with bombs. Later Meteors with more power could carry bombs or rockets.

THRUST

The twin engines fitted to the Meteor gave it comparatively high power, especially when more powerful engines were fitted after the war. It could never match swept-wing types for performance, however, even in its later F.Mk 8 variant.



Worldwide Meteor operators

■ **AUSTRALIA:** No. 77 Squadron of the Royal Australian Air Force flew the F.Mk 8 over Korea between 1951 and 1953. The aircraft accounted for three MiG-15s destroyed and served with distinction in the attack role.

■ **DENMARK:** Denmark placed the first overseas order for factory-fresh F.Mk 8s. The Danish air force received 20 aircraft, all equipped to RAF standard and delivered between January and June 1951.

■ **UNITED KINGDOM:** Using the long-span wings and tail surfaces of the F.Mk 4, with the nose-mounted cameras of the FR.Mk 9, the PR.Mk 10 was an unarmed, high-altitude reconnaissance aircraft; 59 were built and many served in Germany.

GLOSTER/ARMSTRONG WHITWORTH

METEOR NF

● All-weather jet fighter ● RAF and foreign service ● Test machines

Pending the introduction of a purpose-built two-seat, twin-engined jet night fighter to replace the RAF's war weary de Havilland Mosquito, night-fighter variants of jet day fighters were produced. The second of these to enter service (after the de Havilland Vampire NF.Mk 10) was the Meteor NF.Mk 11 of 1951. Three other marks followed, the last of which, the NF.Mk 14, was the final frontline version of the RAF's pioneer fighting jet.

▲ *Armstrong Whitworth's Gloster-designed Meteor night fighters were a stopgap for the RAF until the purpose-built, twin-engined Gloster Javelin became available in early 1956.*

PHOTO FILE

GLOSTER/ARMSTRONG WHITWORTH METEOR NF

◀ Export aircraft
Most exported Meteor night fighters were ex-RAF aircraft. Exceptions were Denmark's 20 NF.Mk 11s ordered in 1952.

▼ New radar for the Mark 12
A new nose was fitted to the NF.Mk 12, some 43 cm (17 in) longer than that of the Mk 11. This housed an American APS-21 radar set.

▲ Missile testing
NF.Mk 11 WM374 was among a number of Meteors used to test the RAF's first air-to-air missile designs. Fireflash, as shown here, was destined for the Swift F.Mk 7 fighter.

▼ Mixed fleet
Having disbanded in 1950, No. 46 Squadron, RAF, re-formed four years later as a fighter unit equipped with both NF.Mk 12s and Mk 14s.

Wartime origins ▶
In plan view the origins of the Meteor night fighter in the RAF's first jet fighter were plain to see. However, it was a much larger aircraft with longer wings and a new tailplane. Rolls-Royce Derwent engines had been used since 1944.

FACTS AND FIGURES

- A number of RAF NF.Mk 11s were later converted to TT.Mk 20 standard for towing high-speed targets.
- NF.Mk 11s were used to test Fireflash and Firestreak air-to-air missiles.
- A French NF.Mk 11 was experimentally fitted with wing-mounted ramjets.
- RAF Meteor NF(T).Mk 14s, with guns removed, were used to give trainee navigators jet flying experience.
- RAF Meteor night fighters saw service during the 1956 Suez Crisis.
- In all, 583 Meteor night fighters were built, including Mk 11 prototypes.

PROFILE

Meteors for all weathers

A hybrid of earlier Meteors, the Mark 11's airframe was based on the T.Mk 7 trainer's fuselage, with the F.Mk 8's tail, and enlarged wings similar to those on the PR.Mk 10. The lengthened nose contained an AI Mk 10 radar set and the 20-mm (0.79-in) cannon were moved from nose to wings.

Busy with Meteor F.Mk 8 production and development of the new Javelin (which would ultimately replace the Meteor), Gloster entrusted Armstrong Whitworth with the Meteor night-fighter programme; AW went on to build more than 550 examples. Entering service with No. 29 Squadron, RAF, at Tangmere, West Sussex, in August 1951, the Mk 11 was followed by the NF.Mk 13, a tropicalized version for service with the Middle East Air Force.

The Mk 12 actually followed the Mk 13 into service in 1953 and featured an improved American APS-21 radar housed in a 43 cm (17 in) longer nose. With uprated Derwent engines, the Mk 12 was also slightly faster.

From March 1954, the last production Meteor, the Mark 14, entered service. Distinguished by its clear-view canopy, even longer nose and Derwent 9 engines, the NF.Mk 14 began to be superseded by the Gloster Javelin from 1956, although the last were not withdrawn until 1961, ending 17 years of frontline Meteor service with the RAF. From the late 1950s onwards, a number of mainly ex-RAF aircraft were exported to Denmark, France, Belgium, Egypt, Israel and Syria.

Medium sea-grey and dark green comprised the standard Meteor NF.Mk 14 camouflage, regardless of theatre.

Nose-mounted radar necessitated the relocation of the aircraft's four British Hispano 20-mm (0.79-in) cannon, which were installed in the outer wings, in a staggered arrangement with the inner pair set further back.

Rolls-Royce Derwent turbofans were first installed in the Meteor Mk III day fighter in 1944. Enlarged nacelles were a feature of the engine and remained so until production of the Mark 14 ceased in 1955. An air brake was fitted inboard of each engine, just behind the trailing edge.

The Meteor NF.Mk 14's tailplane, inherited from the F.Mk 8, featured straight leading and trailing edges, unlike the first Meteor marks.

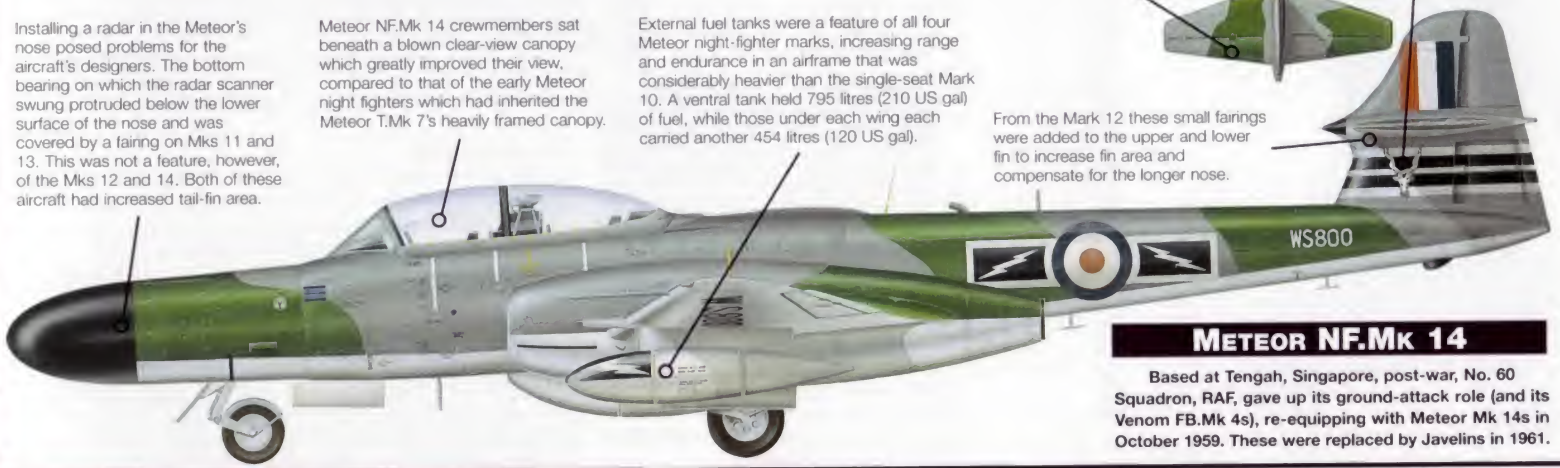
The animal's head in No. 60 Squadron's insignia was that of a markhor, a species found in the Khyber Pass region where the unit had served in the 1920s.

Installing a radar in the Meteor's nose posed problems for the aircraft's designers. The bottom bearing on which the radar scanner swung protruded below the lower surface of the nose and was covered by a fairing on Mks 11 and 13. This was not a feature, however, of the Mks 12 and 14. Both of these aircraft had increased tail-fin area.

Meteor NF.Mk 14 crewmembers sat beneath a blown clear-view canopy which greatly improved their view, compared to that of the early Meteor night fighters which had inherited the Meteor T.Mk 7's heavily framed canopy.

External fuel tanks were a feature of all four Meteor night-fighter marks, increasing range and endurance in an airframe that was considerably heavier than the single-seat Mark 10. A ventral tank held 795 litres (210 US gal) of fuel, while those under each wing each carried another 454 litres (120 US gal).

From the Mark 12 these small fairings were added to the upper and lower fin to increase fin area and compensate for the longer nose.



METEOR NF.MK 14

Based at Tengah, Singapore, post-war, No. 60 Squadron, RAF, gave up its ground-attack role (and its Venom FB.Mk 4s), re-equipping with Meteor Mk 14s in October 1959. These were replaced by Javelins in 1961.

Meteor NF.Mk 14

Type: two-seat night/all-weather interceptor

Powerplant: two 16.90-kN (3,800-lb-thrust) Rolls-Royce Derwent 9 turbojets

Maximum speed: 940 km/h (584 mph) at 3048 m (10,000 ft)

Initial climb rate: 13.2 min to 9144 m (30,000 ft) with ventral and wing fuel tanks

Service ceiling: 12,192 m (40,000 ft) with ventral and wing fuel tanks

Weights: empty 5724 kg (12,620 lb); maximum take-off 9626 kg (21,222 lb)

Armament: four 20-mm (0.79-in) Hispano Mk V cannon with 640 rounds of ammunition

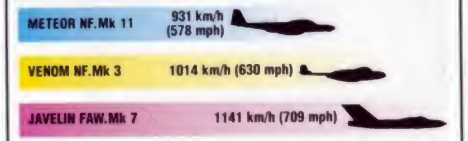
Dimensions:

span	13.10 m (43 ft)
length	15.50 m (50 ft 10 in)
height	4.20 m (13 ft 9 in)
wing area	34.70 m² (374 sq ft)

COMBAT DATA

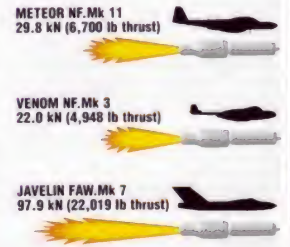
MAXIMUM SPEED

Based on a World War II design, the Meteor was comparatively slow. Night fighters were expected to carry greater weights than other interceptors, but employed engines of only slightly greater power. Gloster's Javelin was fully 200 km/h (124 mph) faster.



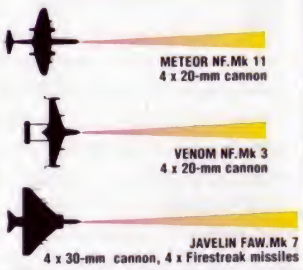
THRUST

The de Havilland Venom had only 22 kN at its disposal, though this came from a single engine. The purpose-designed Gloster Javelin was considerably heavier and more powerful than the Meteor, with almost 100 kN available, and had a much improved performance.



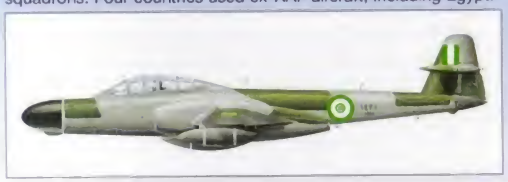
ARMAMENT

By the end of World War II, cannon armament was standard on British fighter aircraft. The Meteor and Venom each carried four 20-mm (0.79-in) cannon. By the time the Javelin entered service, calibres had reached 30 mm (1.18 in) and missiles had been added.

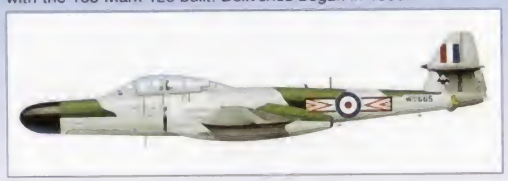


Major Meteor night-fighter marks

METEOR NF.Mk 11/13: Only 40 examples of the 'tropicalized' Mark 13 were completed and equipped two RAF squadrons. Four countries used ex-RAF aircraft, including Egypt.



METEOR NF.Mk 12: No. 153 Squadron was one of nine RAF squadrons and two Operational Conversion Units to be equipped with the 100 Mark 12s built. Deliveries began in 1953.



METEOR NF.Mk 14: Thirteen operational RAF squadrons flew the Mark 14, including No. 72, a fighter unit with a long history stretching back to World War I.

GLOSTER

JAVELIN

● Delta fighter ● Missile-armed pioneer ● Air defence

▲ *The Javelin was an important machine for Britain, as it took the RAF into the era of all-weather missile-armed fighters. If it had been upgraded as planned with an advanced 'thin wing', it could have served into the 1980s.*

The Cold War nuclear threat demanded that NATO air forces deploy radar-equipped interceptors able to halt attacking Soviet bombers far from the West's vulnerable cities. Britain's Gloster Javelin, the world's first twin-jet, delta-winged interceptor, was designed for the job. A two-man long-range interceptor, the Javelin was a little slow and difficult to fly, but its radar and missile combination made it one of the most advanced fighters of the 1950s.

PHOTO FILE

GLOSTER JAVELIN

▲ Base overflight
The RAF was proud of its latest fighter. In 1956 these gun-armed FAW.Mk 1 (Fighter All Weather) aircraft flew a display for the press over their base in Hampshire.

▲ Aerobatics
The Javelin was a heavy, solidly built aircraft, but it was still capable of performing smooth aerobatics: especially the FAW.Mk 8 variant of 1958, which had Sapphire engines of increased power.

Heavyweight ▶
Javelins were monsters compared to the Meteors and Vampires that they replaced.

▼ Gate guardian
Britain still has some Javelins, but only as 'gate guardians' on RAF stations. Although short of performance all through its relatively brief career, the Javelin was well regarded by its users for its power, long range and potent missile armament.

▲ Firestreak armed
The Javelin FAW.Mk 7 was the first RAF fighter which could use the Firestreak infra-red missile. This later armed the Lightning.

FACTS AND FIGURES

- An early version, known as the Gloster GA.Mk 5, first flew on 26 November 1951.
- The Javelin prototype took to the skies for its initial flight on 22 July 1954.
- In February 1956 No. 46 Squadron of the Royal Air Force became the first user of the Javelin.
- The FAW.Mk 8 was the final Javelin, making its first flight on 9 May 1958.
- Modifications to the Javelin's wing improved the aircraft's fuel capacity and its weapons-carrying potential.
- In a production run of only four years 343 Javelins were delivered.

PROFILE

Gloster's mighty delta-winged fighter

Air combat at high speed in poor weather was the aim when the Gloster Javelin became operational in 1956. It had the same role as Meteor night fighters or the American F-94 Starfire – to detect, intercept, identify and destroy bombers. The Javelin was designed to make any air attack so costly that no aggressor would attempt it.

On paper, it was a perfect design – a delta wing for high-altitude performance, but with a high-set tail to reduce the approach angle on landing. In reality, the Javelin's performance was middling and it was a maintenance nightmare – but crews loved it.

The production Javelin was considered quite advanced for its time. Its air-intercept radar was gradually improved, and the Firestreak missile was added to its arsenal. In the end the Javelin gave RAF squadrons a formidable if imperfect weapon, to bolster Britain's defence against atomic attack.

Eight Javelin variants came out of the factory, each offering distinct improvements over its predecessors. In service for more than a decade, the Javelin stood guard until 1967, when it was finally retired from service.

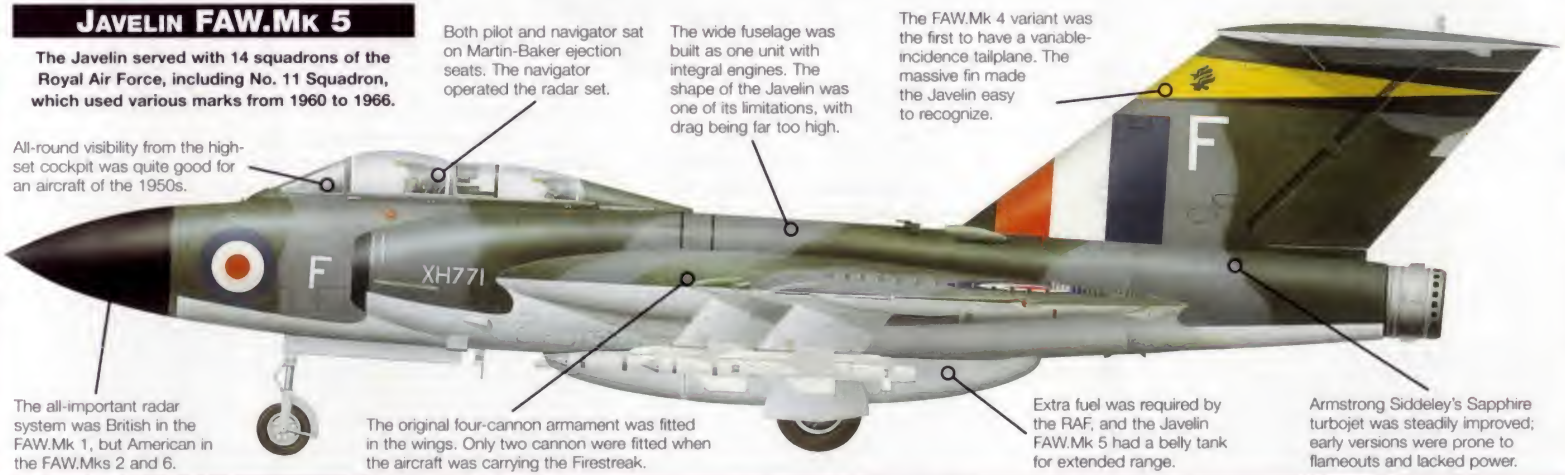
Above: Based in Germany and the Far East, the RAF's Javelins had a vital role in projecting an all-weather air defence capability. They were replaced by the far more capable Lightning.

Above: Like any high-tailed delta, the Javelin needed a careful hand on the controls when landing.

The Javelin's simple, round jet intakes were designed for subsonic efficiency. Giving the fighter extra speed would have called for a major redesign.

JAVELIN FAW.MK 5

The Javelin served with 14 squadrons of the Royal Air Force, including No. 11 Squadron, which used various marks from 1960 to 1966.



Both pilot and navigator sat on Martin-Baker ejection seats. The navigator operated the radar set.

The wide fuselage was built as one unit with integral engines. The shape of the Javelin was one of its limitations, with drag being far too high.

The FAW.Mk 4 variant was the first to have a variable-incidence tailplane. The massive fin made the Javelin easy to recognize.

All-round visibility from the high-set cockpit was quite good for an aircraft of the 1950s.

The all-important radar system was British in the FAW.Mk 1, but American in the FAW.Mks 2 and 6.

The original four-cannon armament was fitted in the wings. Only two cannon were fitted when the aircraft was carrying the Firestreak.

Extra fuel was required by the RAF, and the Javelin FAW.Mk 5 had a belly tank for extended range.

Armstrong Siddeley's Sapphire turbojet was steadily improved; early versions were prone to flameouts and lacked power.

Javelin FAW.Mk 7

Type: two-seat all-weather fighter

Powerplant: two 48.94-kN (11,007-lb-thrust) Armstrong Siddeley Sapphire 203 turbojets

Maximum speed: 1130 km/h (702 mph) at sea level

Range: 1600 km (994 miles)

Service ceiling: 16,000 m (52,493 ft)

Weights: empty 14,324 kg (31,579 lb); loaded 19,578 kg (43,162 lb)

Armament: two 30-mm (1.18-in) ADEN cannon in each wing; four de Havilland Firestreak heat-seeking air-to-air missiles

Dimensions:

span	15.85 m (52 ft)
length	17.15 m (56 ft 3 in)
height	4.88 m (16 ft)
wing area	86.12 m² (927 sq ft)

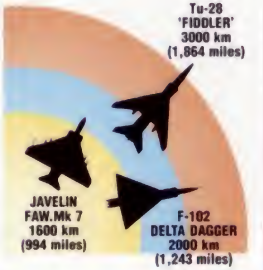
COMBAT DATA

MAXIMUM SPEED

The Javelin contrasted strongly with its counterparts from the Soviet Union and the United States. Its bulky fuselage and thick wing limited it to high subsonic speeds, where the huge Tupolev Tu-28 and the delta-winged Convair F-102 single-seater both had supersonic dash performance.

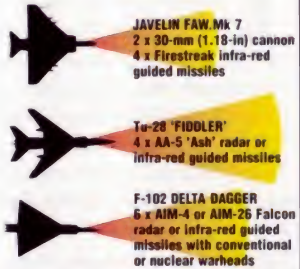
RANGE

The Javelin offered little in the way of increased range over its immediate predecessors, but it was good enough to protect the relatively small air space of the United Kingdom. Superpower air defenders were faced with vastly greater areas to protect, and their interceptors consequently had greater range.



WEAPONS

The late 1950s saw the first large-scale deployment of guided air-to-air missiles. The American Falcon had similar performance but greater range than the British Firestreak, while the larger Soviet 'Ash' missile was capable of making intercepts at much greater distances.



Night and all-weather fighters of the 1950s

DOUGLAS F3D SKYKNIGHT: This carrier-based, purpose-designed two-seat all-weather jet fighter made the first jet-versus-jet kill at night during the Korean War.

NORTHROP F-89 SCORPION: The USAF's purpose-designed all-weather jet, the rocket-armed F-89 entered service in 1951 and was operational until the late 1950s.

AVRO CF-100: The first combat jet designed and built in Canada, the CF-100 became operational in 1952. It was the first straight-wing fighter to exceed Mach 1 in a dive.

YAKOVLEV Yak-25: Codenamed 'Flashlight' by NATO, the Yak-25 was the Soviet Union's first all-weather jet. It became operational in 1952 and served for more than two decades.

DE HAVILLAND SEA VIXEN: This striking twin-boom jet was Britain's carrier-borne equivalent of the Javelin. It served until replaced by the F-4 Phantom in the late 1960s.

GRUMMAN

F9F PANTHER

● Early navy jet ● Korean War MiG-killer ● Tactical fighter-bomber

▲ *The Panther gained many 'firsts' for the US Navy. It was the first USN jet to go to war, the first to use a blown flap and the first to try an inflight-refuelling system.*

The F9F Panther brought the jet age to the US Navy. Although not the USN's first carrier jet, it was the first to reach widespread service and to win real popularity among the Navy and Marine pilots who flew in it. There were reconnaissance and target-drone Panthers, too, but this superbly tough warplane is best remembered as the most important carrier-borne jet fighter of the Korean War.

PHOTO FILE

GRUMMAN F9F PANTHER

▼ Wingtip tanks
Besides being useful perches for the deck crews, the Panther's tip tanks helped to improve the aircraft's rather poor rate of roll.

▲ Swinging guns ▶
This experimental Emerson gun installation was tested, but, like similar projects in Russia by MiG, it was not used in squadron service.

Prototype ▶
Despite being lost in an accident, the first Panther prototype showed promise.

▼ Carrier operations ▶
Although the Panther was basically sound, it had a high landing speed and poor control in certain conditions, providing the US Navy with valuable experience of jet operations at sea.

▼ Rocket ship
A favourite armament of Korean War Panthers was six high-velocity aircraft rockets, used against surface targets.

FACTS AND FIGURES

- The first flight by a Panther prototype was an inadvertent 'hop' during taxi tests on 21 November 1947.
- The Navy's first jet-versus-jet 'kill' was a MiG-15 downed on 9 November 1950.
- Panthers flew 78,000 combat sorties in the Korean 'police action'.
- The only foreign air arm to receive F9Fs was the Argentine air force, which acquired 24 Panthers in 1958.
- Panthers shot down two North Korean Yak-9 prop-driven fighters.
- In total, 1385 Panthers were built by Grumman between 1947 and 1953.

PROFILE

The first Navy jet to go to war

Panthers were usually finished in an all-midnight blue paint scheme. This colour was used on all versions of the aircraft, including the ground attack and reconnaissance variants.

The F9F Panther was the most successful of the first generation of US Navy jets. Originally proposed as a four-jet combat craft, which the navy sensibly rejected, the single-engined Panther was a sturdy warplane which performed well, but required nurturing over time.

Panthers flew in US Navy squadrons with three choices of powerplant (J33, J42 and J48) before the USN settled on the F9F-5 propelled by a J48, based on the Rolls-Royce Tay.

The Panther flew for the first time in 1947, and was the first carrier-based jet fighter to see combat. Extensively used on ground-attack duties in Korea, the Panther was a fine warplane in the hands of a trained pilot. Its structural strength, a trademark of the 'Grumman Iron Works', helped Marines enormously when they flew Panthers through gunfire to attack ground troops in Korea. But in spite of the fact that a Panther gained the US Navy's first jet kill, a MiG-15 in November 1950, the F9F was seriously outclassed by the swept-wing F-86 Sabre and MiG-15 which were entering service.

The last operational Panther was retired in October 1958, but the old fighter continued as a training machine and target tug well into the 1960s.

The thick wingroot, with its engine intakes built into it, was typical of Grumman's famously strong engineering. The folding hinge was unusually close inboard to the fuselage.

F9F-5 Panther

Type: single-seat carrier-based fighter and attack aircraft

Powerplant: one 31.14-kN (7,004-lb-thrust) Pratt & Whitney J48-P-6 turbojet (licence-built Rolls-Royce Tay)

Maximum speed: 932 km/h (579 mph) at 6706 m (22,000 ft)

Range: 2100 km (1,305 miles)

Service ceiling: 13,000 m (42,650 ft)

Weights: empty 4603 kg (10,148 lb); loaded 8492 kg (18,722 lb)

Armament: four 20-mm (0.79-in) Browning M3 cannon each with 190 rounds; up to 1360 kg (3,000 lb) of underwing bombs or rocket projectiles

Dimensions:

span	11.58 m (38 ft)
length	11.84 m (38 ft 10 in)
height	3.73 m (12 ft 3 in)
wing area	23.23 m² (250 sq ft)

F9F-2 PANTHER

This Grumman F9F Panther was used by VMF-311, a US Marine Corps squadron flying ground-attack missions in support of UN forces in Korea.

The 'panther's head' paint scheme was a personal badge.

The Panther suffered instability problems which were never entirely cured. With the hydraulic control boost inoperative, aileron stick forces were very high.

The deep, sturdy fuselage was so shaped because the J42 engine was of centrifugal design. The shape was useful, however, as it gave a very large volume for internal fuel – twice as much as the British Hawker Sea Hawk.

An internal 95-litre (25-US gal) tank of water/methanol was fitted beneath the fin, to give extra engine thrust.

Four 20-mm (0.79-in) cannon were mounted in the nose, which could be slid forward to gain access for reloading.

Panthers had two ventral airbrakes, mounted left and right on the front fuselage.

Although ostensibly a fighter, the Panther usually delivered air-to-ground munitions such as HVAR rockets or bombs.

The strong tailhook and high landing speed caused at least two Panthers to rip their tails off on landing.

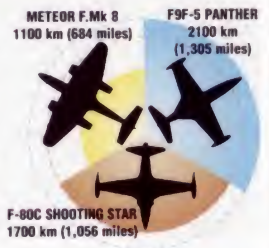
COMBAT DATA

MAXIMUM SPEED

Although heavy and very strongly built to withstand the rigours of carrier operations, the Panther was not much slower than the first generation of straight-winged land-based jets. But by the early 1950s all had been outclassed by the new swept-wing fighters.

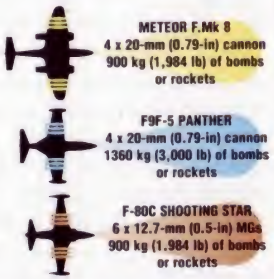
RANGE

Carrier aircraft generally have longer ranges than their land-based counterparts. This is an operational necessity: there are few conveniently placed diversionary fields in the wide expanses of the ocean. For the naval pilot the choice is simple: you make it back to the carrier, or you learn to swim.



ARMAMENT

The US Navy was much quicker than the US Air Force to adopt the heavy cannon armament which had been accepted as standard elsewhere in the last years of World War II. In addition to its cannon, the Panther was able to carry a considerable load of air-to-ground ordnance.



Fighters from the 'Grumman Iron Works'

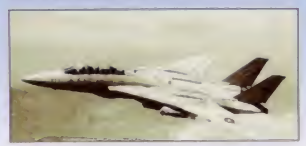
F3F: The first Grumman carrier fighters in the 1930s established all of the company's characteristics, with toughness and agility foremost.

F6F HELLCAT: Swarms of these big, beefy fighters wrested control of the Pacific skies from the fighters of Imperial Japan.

F8F BEARCAT: The last of the great Grumman prop-fighters, the Bearcat missed World War II. It served into the 1950s.

F9F COUGAR: A swept-wing adaptation of the Panther, the Cougar served well into the 1960s, ending as an advanced trainer.

F-14 TOMCAT: Possibly the last Grumman fighter, the Tomcat has been the US Navy's main airborne defender since the 1970s.



GRUMMAN

A-6 INTRUDER

● Two-seat attack ● First Gulf War veteran ● Carrier- and land-based

One of the primary weapon systems of the 1991 Gulf conflict, the 1960s vintage American A-6 Intruder provided tactical bombing and close support airpower from aircraft-carriers and land bases. Initially the Intruders were used at low level, but Iraqi anti-aircraft fire quickly brought about a change in tactics. From medium altitude A-6s were able to wreak havoc unmolested in the last major conflict of the Intruder's long career.

▲ *Lieutenant Colonel Leif Larsen stands in front of his VMA(AW)-533 aircraft. The A-6 fleet (A-6Es and KA-6Ds of the US Navy and Marine Corps A-6Es) was heavily used during Operation Desert Storm.*

PHOTO FILE

GRUMMAN A-6 INTRUDER

◀ Folding wings

This A-6E demonstrates the Intruder's ability to fold its wings for stowage aboard a carrier. Carrier aircraft must be lashed down when parked on a carrier deck in case bad weather is encountered.

▲ Retirement on the horizon

After the 1991 Gulf War the Marine Corps replaced its A-6s with F/A-18s. The US Navy's replacement for the A-6 was the cancelled A-12 Avenger II.

▲ Refuelling

An A-6 takes on fuel from a USAF KC-135 tanker. The majority of the Coalition's tanker force was American, although other refuellers included aircraft from the RAF and the French air force.

▲ Intruder refuels Prowler

US Navy KA-6D tanker variants of the Intruder saw service in the Gulf. This one is refuelling an EA-6B.

▲ Precision-guided munitions

Carrier crewmen load a laser-guided bomb aboard an A-6 prior to a mission. Intruders also delivered a large tonnage of 'iron bombs'.

FACTS AND FIGURES

- A total of seven US aircraft-carriers participated in the 'Desert Shield' build-up and subsequent war.
- Five A-6 Intruders were lost in the Persian Gulf; two crewmen were killed.
- The Marine Corps flew A-6s in Vietnam and the Gulf, but has now retired its fleet.
- Two years before the war the US Navy cancelled the A-6F – an improved Intruder with new radar and turbofan engines.
- Intruders flew 6444 combat sorties from 17 January until 24 February 1991.
- The US Navy has now replaced its A-6s with the new enlarged F/A-18E/F Hornet.

PROFILE

First Gulf War tactical bomber

At dawn on 17 January 1991, the first full day of war, Saddam Hussein's guns sought out many Allied warplanes. Among them were the low-flying A-6 Intruders from no fewer than six US Navy aircraft-carriers, part of the largest sea armada in decades.

The twin-engined, two-seat Grumman A-6 all-weather attack aircraft first flew in 1960. The A-6E was an improved version of the Vietnam-era A-6.

Throughout the 1991 Gulf conflict US Navy A-6s attacked airfields, dams, transport facilities and other targets using a mixture of 'iron' bombs and precision-guided munitions. In addition, land-based Marine Intruders provided air support for ground forces.

Initially low-level attack, a method developed for war in Europe and Korea, was used. But this was a risky tactic against Iraq. An A-6 Intruder shot down on the first night of the war was hit by concentrated anti-aircraft fire encountered at low altitude. Following early losses the Intruders switched to medium altitude, where they were much less vulnerable.

The tanker version of the Intruder, the carrier-based KA-6D, was also in action in the Gulf, providing vital refuelling support to the US Navy. Only the EA-6B Prowler variant remains in service.

Above: Modified USAF tankers were able to refuel US Navy aircraft, such as these A-6 Intruders, during the Gulf War. This greatly improved operational flexibility.

Left: Both US Navy and Marine Corps Intruders were in action during Desert Storm. Navy A-6Es and KA-6Ds operated from aircraft-carriers and Marine A-6Es were based at Bahrain.

A-6E Intruder

Type: two-seat all-weather attack aircraft

Powerplant: two 41.37-kN (9,305-lb-thrust) Pratt & Whitney J52-P-8B turbojets

Maximum speed: 1037 km/h (644 mph) 'clean'

Range: 1627 km (1,011 miles) with maximum warload

Service ceiling: 12,925 m (42,405 ft)

Weights: empty 12,525 kg (27,613 lb); maximum take-off 26,580 kg (16,516 lb) (carrier launch) or 27,397 kg (60,400 lb) (land take-off)

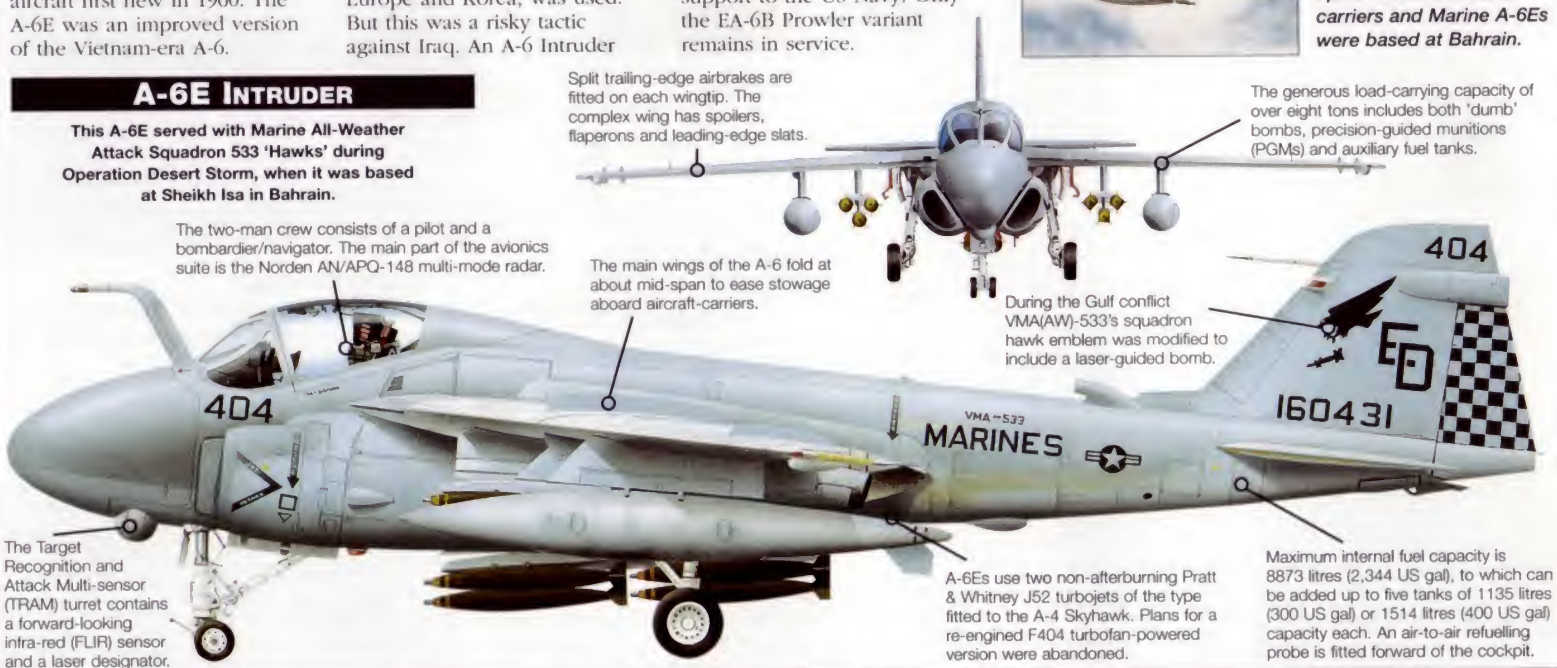
Armament: up to 8165 kg (18,000 lb) of bombs and/or missiles, including AGM-65 Maverick, AGM-84 Harpoon/SLAM and AGM-88 HARM

Dimensions:

span	16.15 m (53 ft)
length	16.69 m (54 ft 9 in)
height	4.93 m (16 ft 2 in)
wing area	49.13 m² (529 sq ft)

A-6E Intruder

This A-6E served with Marine All-Weather Attack Squadron 533 'Hawks' during Operation Desert Storm, when it was based at Sheikh Isa in Bahrain.



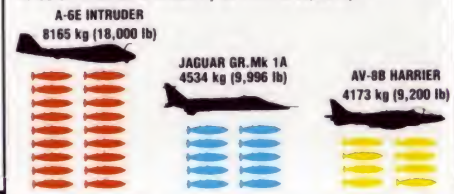
COMBAT DATA

MAXIMUM SPEED

The swept-wing Jaguar, with its afterburning turbofans, has by far the highest top speed among these Gulf War attack aircraft. Like the A-6, the Jaguar was initially deployed on low-level strikes.

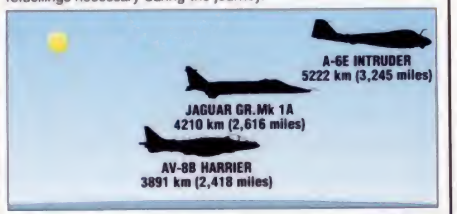
BOMBLOAD

The carrier-based A-6 has an excellent load-carrying capacity. This can be made up of weapons, fuel and other equipment. The AV-8B's bombload is limited by its V/STOL capability.



FERRY RANGE

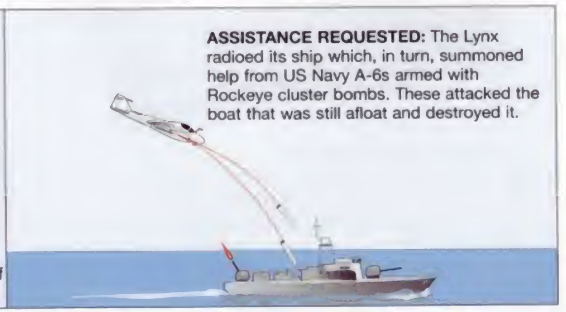
Ferry range is important when an aircraft is required to deploy a long distance from its base. It determines the number of air-to-air refuellings necessary during the journey.



Sinking Iraqi gunboats

FAST PATROL BOAT THREAT: Iraq's small navy in the Persian Gulf included captured Kuwaiti 'TNC45'-class patrol boats equipped with Exocet anti-ship missiles. This threat was met by Royal Navy Lynx helicopters.

PATROL BOATS ENGAGED: On 8 February 1991 a Lynx from a Royal Navy destroyer engaged two patrol boats, but fired all of its Sea Skua anti-ship missiles without destroying them both.



ASSISTANCE REQUESTED: The Lynx radioed its ship which, in turn, summoned help from US Navy A-6s armed with Rockeye cluster bombs. These attacked the boat that was still afloat and destroyed it.

GRUMMAN

F-14 TOMCAT

● Naval interceptor ● Long-range defence ● Upgraded systems

US Navy warships relied on the capabilities of the F-14 Tomcat to protect them from air attack. No job is more challenging: the pilot and radar intercept officer of an F-14 knew that they might be attacking bombers or cruise missiles at great distances. To defend their aircraft-carrier and the other vessels in the Fleet, the Tomcat crew had to seize every advantage offered by the F-14's long-range missiles and far-reaching radar.

▲ *Highly trained crews and considerable combat success have given the Tomcat a legendary reputation. The last Tomcats in US Navy service were retired in 2006.*

PHOTO FILE

GRUMMAN F-14 TOMCAT

▲ Carrier return
After a long mission, possibly involving the extreme stress of air-to-air combat and with little fuel remaining, the pilot had to safely land the F-14 on a rolling, pitching carrier deck.

▲ Tomcat complement
Most aircraft-carriers carried a squadron of about 20 Tomcats as part of their standard air wing complement.

▲ Inner fighter screen
Any attacker which managed to pass through the screen of defending Tomcats would have faced the shorter-ranged F/A-18C Hornet.

▼ Air-to-air refuelling
Tomcats worked in combination with other naval air assets, including KA-6D tankers.

▲ Hawkeye co-ordination
An integral part of the Fleet defence system is the E-2 Hawkeye, which is able to find targets beyond the range of the F-14's radar and direct the battle.

FACTS AND FIGURES

- The Tomcat's Hughes AWG-9 radar could track 24 targets at once and attack six simultaneously.
- Late Tomcats had more powerful engines and advanced avionics.
- The Tomcat could carry more than 7348 kg (16,200 lb) of internal fuel.
- Production of the F-14 Tomcat totalled 712 aircraft, including 80 for pre-revolutionary Iran.
- The prototype F-14 Tomcat completed its maiden flight on 21 December 1970.
- Late-model Tomcats used the General Electric F110-GE-400 turbofan.

PROFILE

Defending the carrier battle group

Flying this super interceptor, the F-14 pilot and back-seater had one of the most important and thrilling jobs in the US Navy. The F-14 Tomcat was the combat champion of the 'outer air battle' – the furious action that erupts when the carrier battle group is threatened with attack.

A long-range interceptor with powerful radar and missiles is really the only answer when the adversary may be a fast, sea-skimming attack aircraft, a high-flying strategic bomber or an unmanned missile. With a Top Gun crew handling its controls and avionics, the F-14 Tomcat could detect, identify, engage and destroy the adversary before that adversary posed any real threat to the carrier battle group.

The F-14 remained one of the world's most formidable warplanes into the 1990s, even though early versions have served for more than 20 years. It was one of the first jets in service with a computer-controlled, automatic variable geometry wing – unswept for slow-speed flight and close combat and swept back when high speed is required. The Tomcat was the only fighter to use the Phoenix missile, which had a superb capability to shoot down attackers at long distance.

Above:The primary long-range weapon of the F-14 is the AIM-54 Phoenix missile, which, in its AIM-54C form, has a range of 148 km (92 miles). To engage targets at such extreme ranges the missile must carry a great deal of fuel, which results in a heavy weapon.

Above: With its long-range kill capability the Tomcat has inspired the phrase 'reach out and touch someone'. This aircraft is ready for a catapult launch.

F-14A Tomcat

Type: two-seat shipboard interceptor

Powerplant: two 92.97-kN (20,910-lb-thrust) Pratt & Whitney TF30-P-412A afterburning turbofans

Maximum speed: 2485 km/h (1,544 mph) at high altitude

Combat radius: 1233 km (766 miles)

Range: 3220 km (2,000 miles)

Service ceiling: 16,150 m (52,986 ft)

Weights: empty 18,191 kg (40,104 lb); maximum take-off 32,098 kg (70,764 lb)

Armament: one M61A1 20-mm cannon with 676 rounds, plus six AIM-7 Sparrow and four AIM-9 Sidewinder missiles, or six AIM-54 Phoenix and two AIM-9 missiles or other weapons weighing up to 6577 kg (14,500 lb)

Dimensions:

span (unswept)	19.54 m (64 ft 1 in)
span (swept)	11.65 m (38 ft 3 in)
length	19.10 m (62 ft 8 in)
height	4.88 m (16 ft)
wing area	52.49 m² (565 sq ft)

F-14D(R) Tomcat

US Navy fighter squadron VF-2 flew the Tomcat for more than 30 years. The squadron is known as the 'Bounty Hunters' and served aboard a number of carriers, including USS *Constellation*.

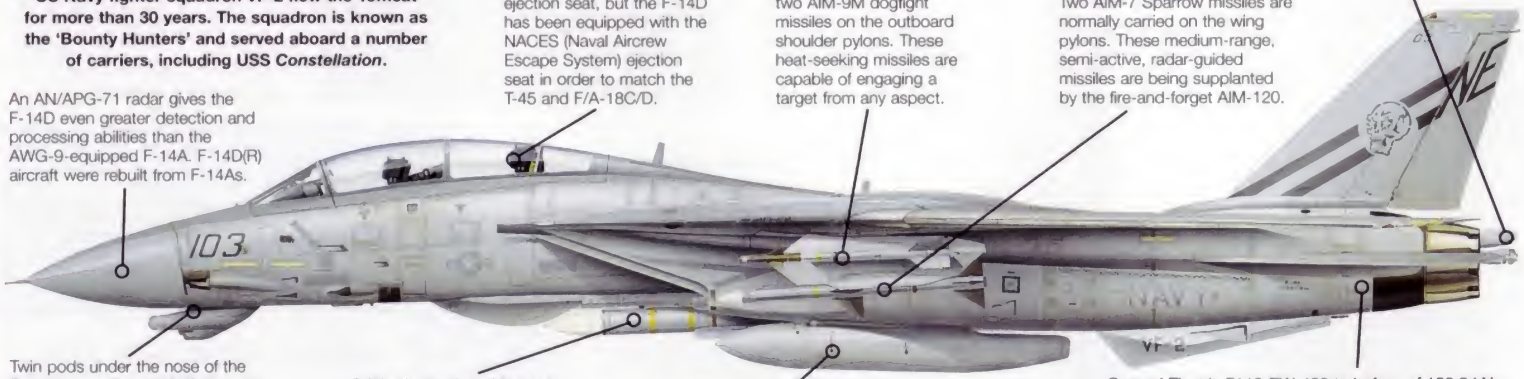
An AN/APG-71 radar gives the F-14D even greater detection and processing abilities than the AWG-9-equipped F-14A. F-14D(R) aircraft were rebuilt from F-14As.

Most Tomcats are fitted with the Martin-Baker GRU-7A ejection seat, but the F-14D has been equipped with the NACES (Naval Aircrew Escape System) ejection seat in order to match the T-45 and F/A-18C/D.

For close-in missile combat the F-14D normally carries two AIM-9M dogfight missiles on the outboard shoulder pylons. These heat-seeking missiles are capable of engaging a target from any aspect.

Two AIM-7 Sparrow missiles are normally carried on the wing pylons. These medium-range, semi-active, radar-guided missiles are being supplanted by the fire-and-forget AIM-120.

An electronic countermeasures antenna fairing and fuel dump pipe are located at the extreme rear of the Tomcat's fuselage. The ALE-39 chaff/flare dispenser is fitted beneath this section.



Twin pods under the nose of the F-14D house the AN/AAS infra-red search-and-track system on the left and AN/AXX-1 television camera system on the right.

Originally developed to equip the ill-fated F-111B, the AIM-54 Phoenix air-to-air missile has remained unique to the F-14.

Auxiliary drop-tanks are available for attachment to hardpoints beneath the engine pods. Each contains 1011 litres (267 US gal) of fuel.

General Electric F110-PW-400 turbofans of 122.8 kN (27,619 lb thrust) give the F-14D 30 per cent lower fuel consumption in afterburning mode and a 50 per cent increase in intercept radius over the F-14A.

COMBAT DATA

MAXIMUM SPEED

Ironically, the re-engined, updated F-14D fell short of its more recent competitors in terms of speed. In the pure interceptor role, however, range, detection ability and firepower are more important.

F-14D TOMCAT	1997 km/h (1,241 mph)
MiG-29K	2300 km/h (1,429 mph)
Su-33 'FLANKER-D'	2300 km/h (1,429 mph)

WEAPON LOAD

With the change to F-14D standard, the Tomcat's ground-attack capabilities were enhanced. The ship-based Flanker has only limited strike capability, especially when compared to the MiG-29K.

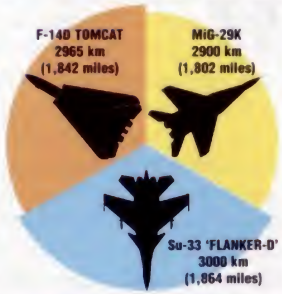
F-14D TOMCAT
6577-kg (14,500-lb) weapon load
1 x 20-mm (0.79-in) cannon

MiG-29K
4500-kg (9,921-lb) weapon load
1 x 30-mm (1.18-in) cannon

Su-33 'FLANKER-D'
6500-kg (14,330-lb) weapon load
1 x 30-mm (1.18-in) cannon

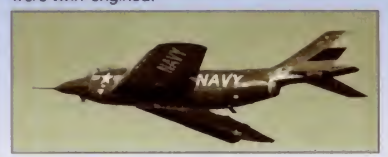
RANGE

Each of these aircraft has exceptional range performance, although the figure shown here for the Tomcat is on internal fuel only and can be improved with drop-tanks and air-to-air refuelling. In addition, the extended search range of the AN/APG-71 radar and the two-person crew of the F-14D make it even more effective.

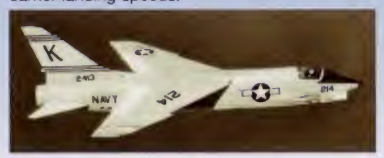


Forty years of fleet defence

■ **McDONNELL F3H DEMON:** First delivered to the US Navy in 1954, the F3H Demon was an all-weather fighter and night fighter. Early aircraft were twin-engined.



■ **LTV F-8 CRUSADER:** With its variable incidence wing the F-8 was able to offer exceptional performance combined with low carrier landing speeds.



■ **McDONNELL DOUGLAS F-4 PHANTOM II:** Many navy pilots preferred the F-8, with its cannon armament, to the all-missile F-4, but the Phantom II was to achieve huge success.

■ **GENERAL DYNAMICS F-111B:** Grumman's F-14 inherited its Hughes APG-9 radar and Phoenix missiles from the troublesome F-111B, which became too heavy to be a naval fighter.

GRUMMAN/GENERAL DYNAMICS

EF-111A RAVEN

● Supersonic electronic warfare aircraft ● Converted F-111A

Retired in 1998, the EF-111 Raven was the USAF's 'secret weapon' – an electronic wizard that jammed and confounded enemy radar and communications. Converted from the famous F-111A 'Aardvark' this big, variable-sweep veteran carried no weapons, but relied instead on the magic of electrons to clear a path through enemy defences for other warplanes. The Raven saw action during the 1991 Gulf War.

▲ *The Raven's role was 'non-lethal defence suppression', which involved jamming enemy radar defences, but the aircraft did not carry air-to-surface weapons to destroy them. That task was left to F-16Cs armed with AGM-88 HARM anti-radar missiles.*

PHOTO FILE

GRUMMAN/GENERAL DYNAMICS EF-111A RAVEN

◀ Jammer's cockpit
Dominating the control panel in front of the electronic warfare officer's right hand station was a large tactical situation display screen providing threat information.

Air-to-air refuelling ▶
As with the F-111 'tanking' was used to extend the already long range of the EF-111. Here a KC-10 is about to refuel a Raven.

◀ Afterburners lit
The immensely powerful TF30-powered F-111 was the ideal platform for a tactical jammer as it was able to keep up with F-111 strike aircraft on long-range missions such as those to Libya and Iraq.

▼ Two-tone grey
The Raven fleet was painted in this two-tone grey colour scheme, the darker shade is on the upper surfaces of the aircraft. This makes it less conspicuous when viewed from above.

▲ 'Electric Fox' and 'Spark Vark'
After the F-111 'Aardvark', the EF-111 was known as the 'Spark Vark'. The type was also called the 'Electric Fox' before 'Raven' was coined by the USAF.

FACTS AND FIGURES

- Skilful manoeuvring by an EF-111 pilot caused an Iraqi Mirage F.1 to crash into the ground early in the 1991 Gulf War.
- The EF-111 had only one set of pilot's controls compared to the F-111's two.
- An EF-111 aerodynamic prototype flew in 1975 and the first full conversion in 1977.
- Though EF-111s used a similar ALQ-99 system to the four-seat EA-6B, greater automation allows just one operator.
- The EA-6B differs from the Raven in being armed with anti-radar missiles.
- The EF-111 will eventually be replaced by the EA-18G Growler.

PROFILE

Supersonic radar jammer

The 1973 Yom Kippur War demonstrated that tactical aircraft were extremely vulnerable to an enemy's large integrated air defence system of the type favoured by the Soviet Union and Warsaw Pact states. The USAF's Tactical Air Command (TAC) had invested little in electronic warfare and was about to retire its EB-66 stand-off jammers.

Grumman had experience with tactical radar jamming systems, having combined the ALQ-99 system with the A-6 Intruder attack aircraft in order to create the EA-6B Prowler carrier-based jammer.

TAC, however, needed a faster platform on which to mount this system, so that it could keep up with its 'strike packages'. It therefore chose the long-range, Mach 2-capable General Dynamics F-111.

The EF-111 combined the proven airframe of a fast, sturdy, long-range strike aircraft with a 'package' of electronic equipment which would enable bombers to reach their targets. By late 1985 Grumman had converted 42 redundant F-111As. Their first use 'in anger' came the following year, supporting the US raids on Libya. At the start of the 1991 Gulf War, the Raven was one of the first aircraft to challenge Iraq's air defences.

The EF-111 has now been replaced in the short term by EA-6B Prowlers, which will eventually hand over to the new EA-18G Growler.

Above: EF-111A serial number 66-0041 was the second F-111A to be converted to Raven standard, but the first to have a full electronics suite installed.

Left: EF-111As drawn from units of the 66th Electronic Combat Wing from RAF Upper Heyford, Oxfordshire, and the 388th Tactical Fighter Wing from Mountain Home AFB, Idaho, performed a vital role in Operation Desert Storm, based at Incirlik, Turkey and Taif, Saudi Arabia, respectively.

EF-111A RAVEN

This Raven belonged to the 430th Electronic Combat Squadron, 27th Fighter Wing, at Cannon Air Force Base, New Mexico. The last unit to fly the EF-111A operationally was the 429th Electronic Countermeasures Squadron.

EF-111A Raven

Type: two-seat supersonic electronic warfare aircraft

Powerplant: two 82.28-kN (18,506-lb-thrust) Pratt & Whitney TF30-P-3 afterburning turbofan engines

Maximum speed: 2272 km/h (1,412 mph) at high altitude

Combat radius: 1495 km (929 miles)

Service ceiling: 13,715 m (45,000 ft)

Weights: empty 25,072 kg (55,274 lb); loaded 40,347 kg (88,950 lb)

Armament: usually none, but able to carry two AIM-9 Sidewinder air-to-air missiles

Equipment: AN/ALQ-99E tactical jamming suite (TJS) consisting of a System Integrated Receiver (of hostile radar emissions) and jamming transmitters; self-defence avionics; mapping radar and terrain-following radar

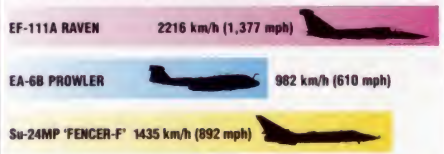
Dimensions:

span (spread)	19.20 m (63 ft)
span (swept)	9.74 m (32 ft)
length	23.16 m (76 ft)
wing area	48.77 m² (525 sq ft)

COMBAT DATA

MAXIMUM SPEED

Based on the Mach 2-capable F-111A strike aircraft, the Raven possessed a similarly impressive performance. The Su-24MP is also based on a supersonic attack aircraft.

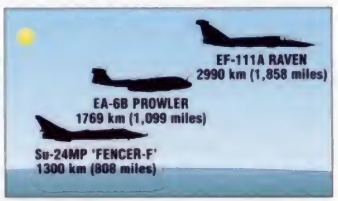


DEFENSIVE ARMAMENT

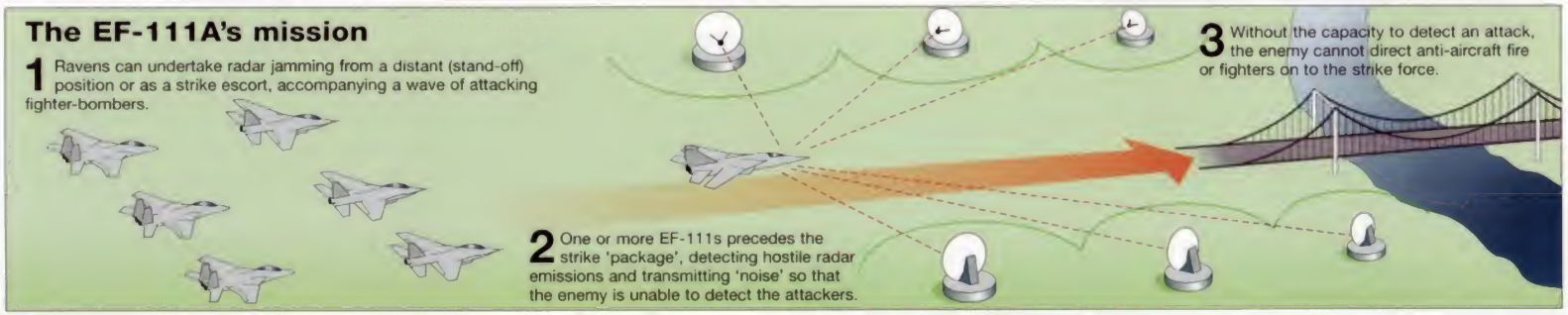
While the EA-6B is capable of carrying up to four AGM-88 HARM anti-radar missiles, it is not equipped with defensive weaponry. The AIM-9 Sidewinder has a considerably better range than the R-60.

RANGE

The F-111 family has an unrivalled range performance in the supersonic deep-strike role. All three types may be refuelled in the air.



The EF-111A's mission



HANDLEY PAGE

VICTOR

● Nuclear bomber ● Missile carrier ● V-bomber

Handley Page's Victor was one of the great post-war jet bombers. This giant, crescent-winged jet belonged to the trio of Britain's epoch-making V-bombers, the others being the Avro Vulcan and Vickers Valiant, and in many ways was the most advanced of the three. It brought powerful new capabilities to the job of strategic bombing, previously carried out by propeller-driven aircraft. After the Cold War the Victor served as a tanker.

▲ *Despite the genius of its design, the Victor's lengthy development and the advent of advanced surface-to-air missiles meant that it actually flew as a bomber for only a small part of its career.*

PHOTO FILE

HANDLEY PAGE VICTOR

▲ Blue Steel alert
This Victor carries a Blue Steel missile in its weapons bay. The missile used liquid fuel and required extensive preparation before flight.

▲ Crescent wing
The crescent shape wing was unique, designed to maintain the same critical Mach number over the whole area.

▲ First of the Victors
The last of the V-bombers to enter service, the Victor prototype finally flew in 1952. The nose was slightly lengthened and the tailplane shortened in the production aircraft.

▲ Missile armed
To maintain the credibility of Britain's deterrent, the Victor often carried live Blue Steels on patrols.

Gleaming white ▶
The Victor's all-white paint scheme was intended to reflect the flash from its own nuclear weapons.

FACTS AND FIGURES

- On 1 June 1957 a Victor exceeded Mach 1 in a shallow dive, the largest aircraft ever to fly supersonic at that time.
- The prototype Victor first flew on 24 December 1952, but crashed in 1954.
- Victors could carry the 'Grand Slam' bomb used by the wartime Lancaster.
- For defence, Victors were fitted with a top-secret electronics countermeasures system called 'Red Steer'.
- An escape capsule was originally considered for the Victor design.
- Victors fired Blue Steels in trials in the desert near Woomera, Australia.

PROFILE

The crescent-winged avenger

Designed to carry nuclear bombs to the Soviet Union, the Victor suffered from a protracted development compared to its rivals, only entering service in 1958, 12 years after design had started. The Victor had a larger bomb-carrying capacity than the other V-bombers and would have been at the vanguard of a strategic strike if war had come. It was equipped with the Blue Steel nuclear-tipped stand-off missile, but the weapon was never used outside trials.

The Victor was in many ways a very advanced aircraft. Its wing was crescent-shaped, with the angle of sweep being highest inboard and decreasing outboard. This idea had first been studied by the German manufacturer Junkers at the end of World War II. Handley Page built the HP.88 research aircraft to test this radical design, and it proved its worth when a Victor was dived supersonically in tests. The nose shape, which looks as if it was designed to fly in space, remains highly unusual even today.

Painted a bright white for nuclear warfare, the Victor fleet acquired grey and green upper surfaces when the RAF began practising conventional and nuclear low-level bombing. Some Victors became reconnaissance aircraft, but a larger number finished their days as tanker aircraft.

Below: Like the Vulcan, the Victor needed more power and a bigger wing to be a real success, and the B.Mk 2 was fitted with Rolls-Royce Conway turbojets. Thirty of this version were built, many being converted for reconnaissance.

Above: Despite its potential, the Victor had a short career as a bomber, entering squadron service in 1958 and standing down in 1968.

Victor B.Mk 2

Type: five-seat long-range strategic bomber

Powerplant: four 91.64-kN (20,611-lb-thrust) Rolls-Royce Conway RCo.17 Mk 201 turbofan engines and two 35.60-kN (8,010-lb-thrust) de Havilland Spectre rocket motors

Maximum speed: Mach 0.98 or 1038 km/h (645 mph) at 12,200 m (40,026 ft)

Range: 6500 km (4,039 miles)

Service ceiling: 16,765 m (55,000 ft)

Weights: empty approx. 51,820 kg (114,244 lb); maximum loaded approx. 10,115 kg (22,300 lb)

Armament: one Avro Blue Steel Mk 1 stand-off missile; or 35 to 48 454-kg (1,000-lb) conventional bombs

Dimensions:

span	36.57 m (120 ft)
length	35.03 m (114 ft 11 in)
height	8.57 m (28 ft 1 in)
wing area	241.30 m² (2,597 sq ft)

Victor B.Mk 2

The Victor was the only V-bomber never to be used as a bomber in war. A total of 86 Victors were built, the final aircraft leaving the production line in May 1963.

The large bulged pods in the wings contained additional fuel to that in the main wing tanks.

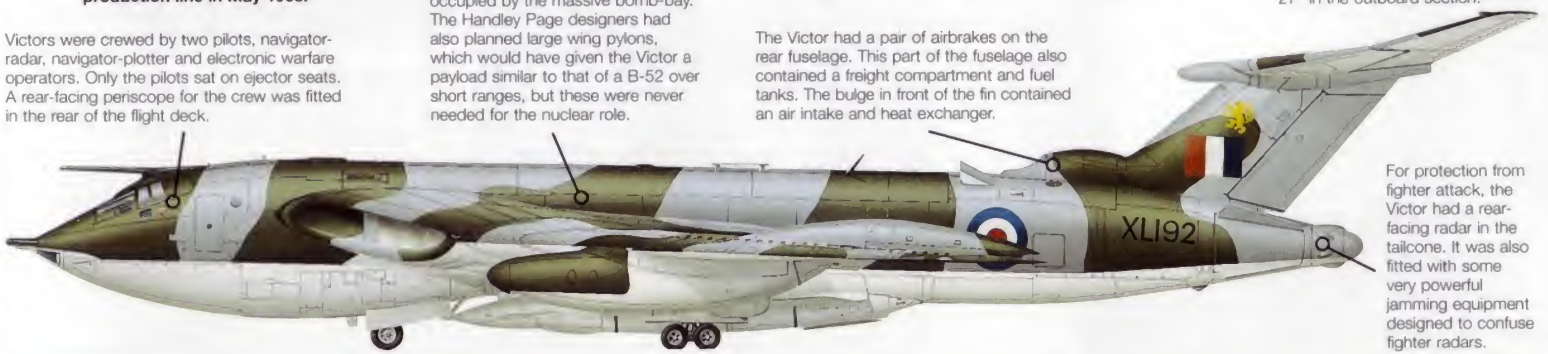
Like its V-bomber brethren, the Victor's turbojets were buried in the wingroots. This was an elegant solution in terms of aerodynamics, but a source of irritation to the engineers servicing the engines.

The wing was swept at 48° inboard, 35° in the centre and 27° in the outboard section.

Victors were crewed by two pilots, navigator-radar, navigator-plotter and electronic warfare operators. Only the pilots sat on ejector seats. A rear-facing periscope for the crew was fitted in the rear of the flight deck.

Much of the centre fuselage was occupied by the massive bomb-bay. The Handley Page designers had also planned large wing pylons, which would have given the Victor a payload similar to that of a B-52 over short ranges, but these were never needed for the nuclear role.

The Victor had a pair of airbrakes on the rear fuselage. This part of the fuselage also contained a freight compartment and fuel tanks. The bulge in front of the fin contained an air intake and heat exchanger.



For protection from fighter attack, the Victor had a rear-facing radar in the tailcone. It was also fitted with some very powerful jamming equipment designed to confuse fighter radars.

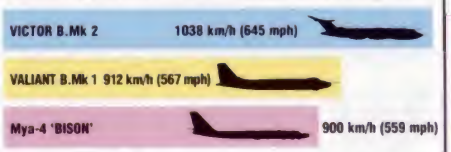
COMBAT DATA

SERVICE CEILING

All the V-bombers had excellent high-altitude performance, which was their primary defence against fighter attack. The MiG-17 could only just reach 16,000 m (52,493 ft). In later years fighter ceilings improved and this advantage was lost. Bombers then had to resort to low-altitude weapons delivery.

MAXIMUM SPEED

The crescent wing and very streamlined fuselage gave the Victor a high speed. It was as fast as many Soviet jet fighters of the early 1950s. The earlier Valiant and Mya-4 had much straighter wings which limited their top speed. Eventually fighter speeds increased significantly and easily outstripped those of bombers.



WEAPON LOAD

The standard load of a Victor was 15 tonnes (16.5 tons), which compared very favourably to most bombers of the time. The Victor could actually lift considerably more at the expense of range. The Valiant was the first of the V-Bombers and was fairly quickly superseded by the Vulcan and Victor.

Nuclear bombers of the Cold War

■ **AVRO VULCAN:** The most successful of the RAF's V-Bombers, the Vulcan also started life as a nuclear bomber. In service until the 1980s, a few saw action in the Falklands War.

■ **BOEING B-52 STRATOFORTRESS:** Boeing's giant, eight-engined B-52 was the backbone of USAF's Strategic Air Command from the 1960s into the 1980s.

■ **TUPOLEV Tu-16 'BADGER':** The smaller cousin of the Tu-95, the twin turbojet-powered Tu-16 was built in large numbers by the Soviet Union. Nuclear and conventional versions exist.

■ **TUPOLEV Tu-95 'BEAR':** The largest turboprop bomber ever built, the Tu-95 shocked the West with its speed when it appeared in the 1950s. It remains in service in Russia.

HAWKER

HUNTER F.MKS 1-5

● Second generation RAF jet ● First British swept-wing fighter

▲ *The engine air intake proposed for the nose of the original design was moved to the wingroots on either side of the fuselage. Radar ranging equipment replaced it.*

With the Hawker Hunter the RAF had a jet fighter that represented a major improvement over the first-generation Gloster Meteors and de Havilland Vampires which were serving in the early 1950s. Popular with pilots as it had almost flawless handling qualities and few limitations, the Hunter was very robust and saw almost two decades of frontline service. However, the early marks had various performance problems that needed to be rectified.

PHOTO FILE

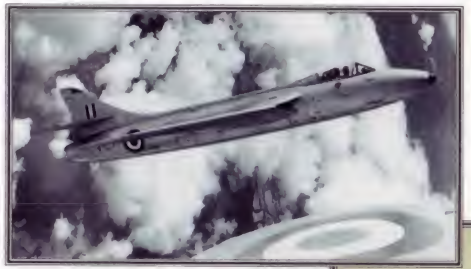
HAWKER HUNTER F.MKS 1-5

◀ Overseas sales
Sweden's air force bought 120 Hunter F.Mk 50s (an export version of the F.Mk 4) in 1955.

▼ Gun problems
Early Hunters had gun firing problems that caused their engines to surge.

▼ Airbrakes
The fitting of a 'barn-door' style airbrake below the Hunter's rear fuselage solved a major combat stability problem.

▼ Weapons
Hunter F.Mk 4s were later able to carry eight rocket packs on underwing pylons.



▼ Classic lines
Throughout its development the Hunter retained its sleek swept wings, tail and fuselage profile.

▲ Sapphire engine
This Hunter F.Mk 2 and F.Mk 5 were powered by an Armstrong Siddeley Sapphire turbojet and were 19.05 cm (7½ in) longer than the original F.Mk 1.

FACTS AND FIGURES

- The prototype Hunter was first flown in July 1951, the production F.Mk 1 entering service in 1954.
- More than 650 Hunters of Marks 1-5 were built; only 150 were Sapphire-powered.
- Flaps were used as airbrakes initially, but this caused control problems.
- The prototype Hunter was fitted with reheat and other improvements to make an attempt on the world air speed record.
- The Hunter F.Mk 3 set a new world speed record of 1171 km/h (728 mph) in 1953.
- The first Hunter F.Mk 1 display team was formed by No. 54 Squadron in 1956.

PROFILE

First of the successful Hunters

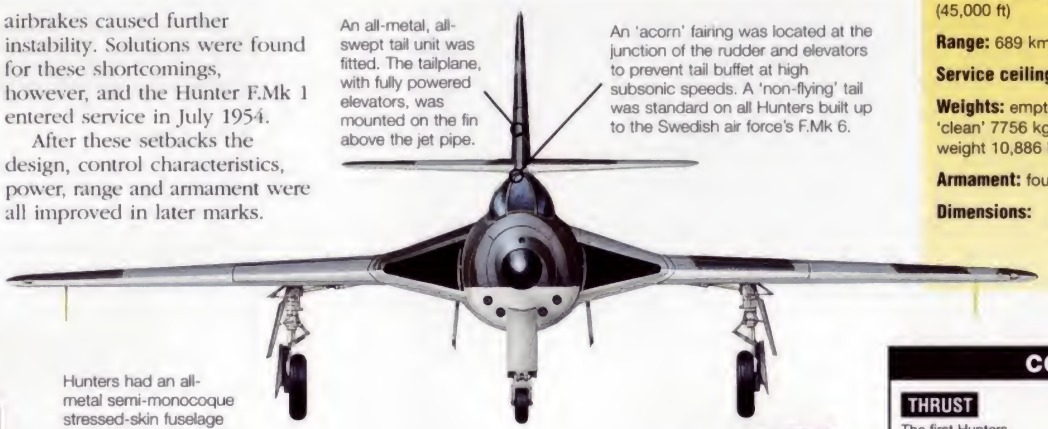
After the North American XP-86 swept-wing fighter first flew at the end of 1947, Britain found itself falling behind in fighter development. The Gloster Meteor and DH Vampire lacked the potential of the new 'second generation' swept-wing jet fighters.

The RAF had an urgent need for a swept-wing design to replace the first jet fighters, with an armament of four cannon, an endurance of one hour and a level speed of Mach 0.94 being specified. It was to be powered by either a Rolls-Royce Avon or an Armstrong Siddeley Sapphire axial-flow turbojet. Before the first prototype Hunter, the Hawker P.1067, was flown in July 1951, a contract for 113 aircraft had been placed. These initial Hunter F.Mk 1s had many problems that prevented their introduction into service for more than a year after many of them were built.

The Rolls-Royce Avon engines had bad surge characteristics in combat at high altitude, made worse when the guns were fired. Manual controls proved to be inadequate and had to be replaced by powered controls, and the use of the flaps as airbrakes caused further instability. Solutions were found for these shortcomings, however, and the Hunter F.Mk 1 entered service in July 1954.

After these setbacks the design, control characteristics, power, range and armament were all improved in later marks.

Ammunition link collectors and underwing pylons have been omitted from this No. 56 Squadron F.Mk 1.



An all-metal, all-swept tail unit was fitted. The tailplane, with fully powered elevators, was mounted on the fin above the jet pipe.

An 'acorn' fairing was located at the junction of the rudder and elevators to prevent tail buffet at high subsonic speeds. A 'non-flying' tail was standard on all Hunters built up to the Swedish air force's F.Mk 6.

Hunter F.Mk 5

Type: single-seat interceptor fighter

Powerplant: one 35.59-kN (8,005-lb-thrust) Armstrong Siddeley Sapphire 101 turbojet

Maximum speed: 978 km/h (608 mph) at 11,000 m (36,089 ft)

Initial climb rate: 8 min 12 sec to 13,720 m (45,000 ft)

Range: 689 km (428 miles)

Service ceiling: 15,240 m (50,000 ft)

Weights: empty 5689 kg (12,542 lb); loaded 'clean' 7756 kg (17,100 lb); maximum take-off weight 10,886 kg (24,000 lb)

Armament: four 30-mm (1.18-in) ADEN cannon

Dimensions:

span	10.29 m (33 ft 9 in)
length	13.98 m (45 ft 10 in)
height	4.01 m (13 ft 2 in)
wing area	33.42 m² (360 sq ft)

HUNTER F.MK 1

WW645 was the last Hunter Mark 1 built for the RAF. It flew with No. 43 Squadron, the 'Fighting Cocks', at RAF Leuchars from mid-1954 until autumn 1957. By then the unit had re-equipped with Hunter F.Mk 6s.

Four Hispano 20-mm (0.79-in) cannon equipped the Hunter F.Mk 1, rather than two of the new 30-mm (1.18-in) ADEN cannon that were not ready for service when the Hunter F.Mk 1 was built.

Hunters had an all-metal semi-monocoque stressed-skin fuselage that was manufactured in three sections. The single-piece, sliding cockpit canopy covered a fully automatic Martin-Baker Mk 2H ejector seat with the Duplex drogue system.

The Hunter had a detachable rear fuselage for ready access to the engine. The rear section included the removable jet-pipe, and the base of the fin and tail.

The mid-set wing widened as it joined the fuselage to incorporate the engine air intakes. The wing was swept nearly 40° at 25 per cent chord. The wide track undercarriage main wheels retracted into the wing.

Production Hunters had a forward end hinged airbrake on the underside of the rear fuselage. It could be lowered to an angle of 67°, presenting a large surface area to the slipstream and slowing down the aircraft effectively.

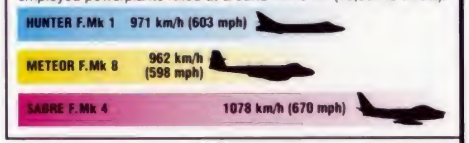
COMBAT DATA

THRUST

The first Hunters to enter service were a little short on thrust compared to the twin-engined Meteor F.Mk 8, but represented a major advance over the single-engined Canadair-built F-86 Sabre.

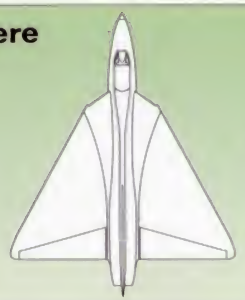
MAXIMUM SPEED

While the first Hunters were faster than the RAF's Meteor F.Mk 8s, they were at least 100 km/h (62 miles) slower than the Sabre F.Mk 4s. This lack of speed was addressed in later Hunter variants, which employed powerplants rated at around 44.48 kN (10,004 lb thrust).

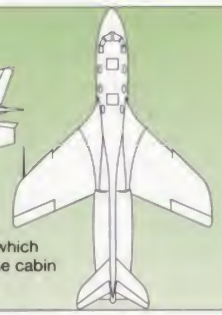


Hunter derivatives that never were

P.1091: This delta-winged Hunter derivative was proposed in 1951 and had an afterburning version of the Sapphire turbojet installed. It was expected to achieve a top speed of Mach 0.98.



P.1100: With an afterburning Rolls-Royce Avon engine and two rocket boosters, the P.1100 was expected to reach Mach 1.5. This 1955 proposal was to be armed with two ADEN guns and two Firestreak missiles.



P.1128: Two Bristol Orpheus turbojets would have powered this 1957 passenger transport proposal, which used standard Hunter wings and undercarriage. The cabin would have accommodated five or six passengers.

HAWKER SIDDELEY

HARRIER GR.MK 1/GR.MK 3

● Pioneering 'Jump Jet' ● V/STOL close support ● Ground attack

The Hawker Siddeley Harrier was a great aviation breakthrough. Designed in the late 1950s by Sydney Camm, the Harrier became the world's first V/STOL (vertical/short take-off and landing) combat aircraft. No other warplane could rise vertically like a helicopter and also fly level like a conventional fighter-bomber. For years the early Harrier, called the 'Jump Jet' for its ability to spring abruptly skyward, enjoyed a monopoly in the vertical flight arena.

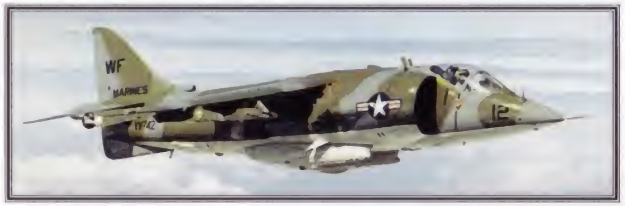
▲ *The Harrier's astonishing ability to take off and land vertically liberated its users from the tyranny of the runway, basing aircraft anywhere from car parks to forest clearings.*

PHOTO FILE

HAWKER SIDDELEY HARRIER GR.MK 1/GR.MK 3

▲ Hard hitter
Although it could not carry as much armament as a more conventional ground-attack jet, the Harrier still packed a considerable punch, especially with SNEB high-explosive rockets.

▲ Harrier at war
Harrier's V/STOL ability meant that RAF ground-attack variants could operate alongside Sea Harriers from Royal Navy decks during the Falklands War.



▲ Export to America
The Harrier was one of the few foreign aircraft ever bought by the Americans. The US Marine Corps operated 110 Harriers as the AV-8A.

▼ Reinforcement specialist
Harriers were often assigned to British mobile forces, and were regularly used on exercises to reinforce Norway and NATO's northern flank.

▲ Marine Corps warrior
In spite of its relatively poor range and weapons load, the US Marine Corps saw the Harrier, or AV-8, as the best solution to the need for very close support during amphibious assaults.

FACTS AND FIGURES

- The prototype for the Harrier series, known as the P.1127, first flew on 21 October 1960.
- On 7 March 1964 a pre-production version, the Kestrel, had its maiden flight.
- The RAF ordered 132 Harrier GR.Mk 1 single-seaters and 19 T.Mk 2 trainers.
- The 'Jump Jet' entered service on the RAF's fifty-first birthday, 1 April 1969.
- The US Marine Corps overcame Pentagon resistance to order Harriers, and started flying AV-8s in 1971.
- The first generation of GR.Mk 1s and 3s have been replaced by modern variants.

PROFILE

Upwardly mobile

The Harrier GR.Mk 1 – the predecessor of today's advanced Harriers and the inspiration for the advanced F-35 JSF – has a special place in aviation history. When Britain's Royal Air Force began flying this first operational Harrier in 1969, it showed that you could fight a war without conventional airfields.

Harrier GR.Mk 1s served with remarkable success – and an enviable safety record – with RAF Germany. For 20 years bomb-laden Harriers standing ready to fight were key participants in the Cold War.

The notion of a V/STOL combat plane, proven during the years when GR.Mk 1s served in Germany, had wide appeal. The US Marine Corps picked up the idea and, although there were some troubles initially, the Marines had enough confidence in the concept to sponsor advanced new versions of the Harrier.

Pilots did not master the Harrier easily, but, once they invested the effort, they commanded an aircraft with unique and exciting performance. It was also agile: in a dogfight the Harrier could hold its own with any fighter in the sky.

Above: The Royal Air Force operated one Harrier squadron in Britain and three in Germany. The original 71 Harrier GR.Mk 1s were followed by 40 GR.Mk 3s, which had a more powerful engine.

Below: The Harrier proved the concept of using high-performance jets at sea without the need for conventional aircraft-carriers. Here an early Harrier uses its vectored thrust to make a vertical landing on the helicopter cruiser HMS Blake.

Harrier GR.Mk 1

Type: single-seat V/STOL ground-attack/ reconnaissance aircraft

Powerplant: one 84.52-kN (19,010-lb-thrust) Rolls-Royce (Bristol Siddeley) Pegasus Mk 101 vectored-thrust turbofan

Maximum speed: 1186 km/h (9737 mph)

Range with one air refuelling: 5560 km (3,455 miles)

Service ceiling: 15,240 m (50,000 ft)

Weights: basic operating weight 5580 kg (12,302 lb); maximum take-off 11,340 kg (25,000 lb)

Armament: up to a maximum of 2268 kg (5,000 lb) of stores on underfuselage and underwing hardpoints, including a 30-mm (1.18-in) ADEN gun pod, bombs, rockets, flares and a five-camera reconnaissance pod

Dimensions:

span	7.70 m (25 ft 3 in)
length	13.87 m (45 ft 6 in)
height	3.45 m (11 ft 4 in)
wing area	18.68 m² (201 sq ft)

HARRIER GR.MK 3

No. 3 Squadron is one of the oldest units in the world, having been in existence since 1912. It was the fourth and last RAF squadron to convert to the original Harrier, flying the type between 1972 and 1988 from its base at Guterstöh.

Harrier pilots sit on a Martin-Baker Mk 9D rocket-powered ejection seat. This can blast a pilot to safety at all speeds and altitudes.

The key to the Harrier's V/STOL performance is the system used to vector engine thrust. The Pegasus has four swivelling jet nozzles which provide lift when pointing downwards and conventional thrust when pointing to the rear.

In common with most modern combat aircraft, the Harrier ended its career after being fitted with a radar-warning receiver which was able to detect and classify hostile radar transmissions.

The view ahead from the Harrier's cockpit is excellent, although all-round visibility is poor.

The extended nose of the Harrier GR.Mk 3 houses the Ferranti laser-rangefinder and marked target seeker, which can search for and detect energy reflected from a target by a ground-based designator.

A single Rolls-Royce Pegasus engine powers the Harrier.This is one of the most powerful jet engines currently used in combat aircraft: in the GR.Mk 3 it delivered nearly 10 tonnes (11 tons) of thrust *without* afterburning.

Two 30-mm (1.18-in) ADEN cannon, each with 150 rounds, are mounted in pods slung beneath the Harrier's fuselage. These are very accurate and can be used against both ground and air targets.

The MATRA SNEB rocket pod contains 19 unguided rocket projectiles with 'flip-out' stabilizing fins. Available with both HEAT and fragmentation warheads, the 68-mm (2.68-in) rockets are effective against most armoured targets.

At hovering speeds, when aerodynamic surfaces have no effect, the Harrier is controlled by 'puffer' jets in the nose, tail and wingtips. These operate on high pressure air bled from the engine.

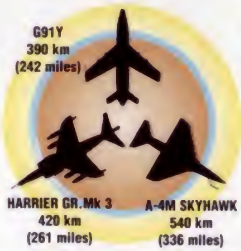
COMBAT DATA

MAXIMUM SPEED

The Harrier was not built for supersonic speed, but its subsonic performance was excellent, thanks to the immense power of its Pegasus engine. It had good acceleration, but the GR.Mk 3 with more equipment and greater weight was a little slower than the original Harrier GR.Mk 1 of 1969.

COMBAT RADIUS

The Harrier was criticized for its lack of range, but its combat radius was about average for light-attack aircraft used in the 1960s and 1970s. It could outperform the Fiat G91Y, designed a decade earlier, but was not as good as the amazing A-4 Skyhawk of the 1950s. However, neither of the older jets could fly vertically.



BOMBLOAD

Another area of criticism was the Harrier's relatively light weapons load. Again, this was slightly unjustified: most of the preceding generation of attack aircraft were limited to an even smaller load, with only exceptional designs such as the Skyhawk being able to carry more.

Development of the early Harriers

■ **P.1127 PROTOTYPE:** First flown in 1961, the Hawker Siddeley P.1127 proved the V/STOL fighter-bomber concept. An enlarged version known as the Kestrel was used for tri-partite trials in Britain, Germany and the United States.

■ **HARRIER GR.Mk 1/AV-8A:** The first production Harriers were larger and heavier than the prototypes, and went into service in Britain, Spain and the United States. The American and Spanish Harriers had the more powerful engine of the RAF's GR.Mk 3.

■ **HARRIER GR.Mk 3:** The more powerful GR.Mk 3 was fitted with better attack systems. Forty-seven US Marine AV-8A Harriers, which served until 1987, were upgraded to AV-8C standard, with strengthened airframe, better avionics and communications.

HAWKER SIDDELEY

NIMROD MR

● Anti-submarine ● Search and rescue ● Maritime patrol

▲ *The Nimrod is a complete anti-submarine and anti-ship battle station. Its unique four-jet configuration allows the aircraft to chase a contact faster than any other maritime aircraft.*

Prowling the oceans of the world, the Nimrod is uniquely qualified to oversee surface shipping and to hunt down hostile submarines. Descended from the Comet jetliner, but in such modified form that when it first appeared it was in many ways a totally new design, the Nimrod is the world's only four-jet maritime patroller, able to detect and sink submarines, or mount anti-shipping strikes with Harpoon missiles. Much of its time is spent in a humanitarian role, however, mounting and coordinating search-and-rescue operations after accidents at sea.

PHOTO FILE

HAWKER SIDDELEY NIMROD MR

◀ Filling up

The Nimrod fleet was hastily modified with air-to-air refuelling probes during the Falklands War in 1982. This allowed the Nimrod to make long surface search patrols into the South Atlantic, with missions often lasting well over 12 hours.

To the rescue ▶

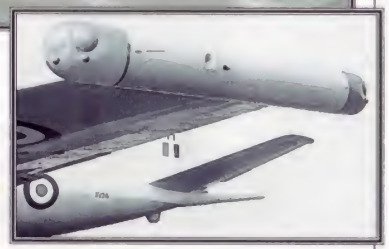
If a shipping disaster occurs, Nimrods are sent to locate the ship and monitor the scene, guiding in rescue ships or helicopters.

Sidewinder armed ▶

The Nimrod received the capability to fire Sidewinders during the Falklands War. The aircraft never used them in anger.

▼ Close watch

Following up a radar contact, the Nimrod closes for a visual check on this 'Kotlin'-class destroyer.



▲ Electronic support

The Loral electronic support measures pod allows the Nimrod to analyse radar and radio transmissions. This information can then be programmed into a special computer 'threat library'.

FACTS AND FIGURES

- The first Nimrod was an aerodynamic prototype which flew on 23 May 1967.
- The Nimrod first entered service with the RAF in October 1969.
- Seven aircraft were used in the unsuccessful effort to develop an airborne early-warning version of the Nimrod.
- The Nimrod needs 1465 m (4,806 ft) of runway to take off and 1615 m (5,298 ft) to land.
- During Operation Desert Storm, Nimrods flew patrols from Seeb airfield, Oman.
- All Nimrod aircraft were upgraded in the mid-1970s; after the 1982 Falklands War all acquired air-refuelling probes.

PROFILE

The mighty ocean hunter

In 1964, Hawker Siddeley (now part of British Aerospace) began work on a naval reconnaissance aircraft based on the Comet 4C to replace the Royal Air Force's worn-out Shackletons. The Nimrod has a distinctive bulged fuselage, a fin-tip radome and a tailboom for magnetic anomaly detection (MAD) gear. It is far from pretty, but is perhaps the world's best maritime ASW (anti-submarine warfare) aircraft, superior in performance to the Lockheed P-3 Orion and Breguet Atlantic. From 1969 onwards, the Nimrod has served the RAF valiantly. Improvements to the basic design came with both the 1982 Falklands conflict and the 1991 Gulf War.

A trio of Nimrods went to the RAF for the very different job of ELINT (electronics intelligence) gathering, snooping on an enemy's activity with hi-tech 'black boxes'. One of the three was lost in an accident in 1995. A planned airborne early-warning version of the Nimrod – in effect, a flying radar station – never overcame technical difficulties, and Britain purchased Boeing's E-3 Sentry AWACS instead.

The Nimrod is now getting old and is progressing towards retirement, but it will remain on active duty well into the twenty-first century.

A replacement for Nimrod is currently under consideration, but it will not be easy to find an aircraft with the combination of superb mission equipment, long-range performance and tough low-level maritime flying.

Nimrod MR.Mk 2

Type: long-range maritime patrol aircraft

Powerplant: four Rolls-Royce RB.168-20 Spey Mk 250s each rated at 54.00 kN (12,145 lb thrust) dry

Maximum speed: 926 km/h (575 mph)

Cruising speed: 880 km/h (547 mph)

Ferry range: 9266 km (5,758 miles)

Service ceiling: 12,800 m (41,995 ft)

Weights: empty 38,937 kg (85,841 lb); loaded 87,091 kg (192,003 lb)

Armament: capability for Sting Ray torpedoes, Harpoon or Sidewinder missiles

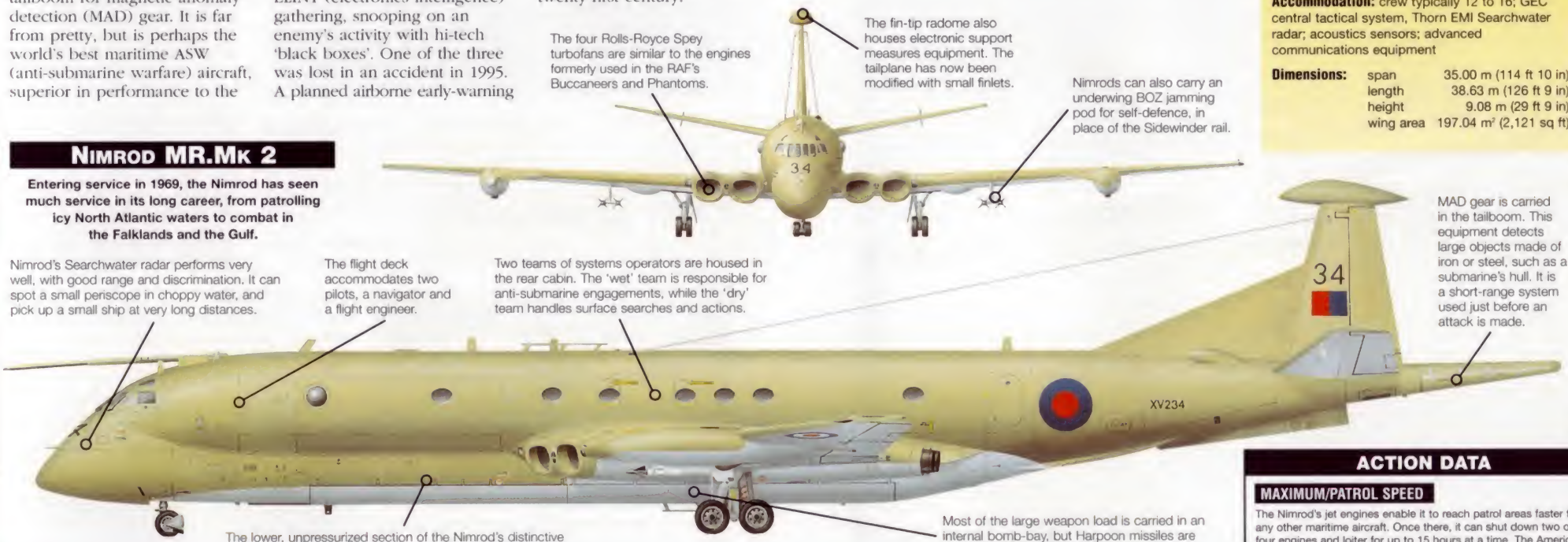
Accommodation: crew typically 12 to 16; GEC central tactical system, Thorn EMI Searchwater radar; acoustics sensors; advanced communications equipment

Dimensions:

span	35.00 m (114 ft 10 in)
length	38.63 m (126 ft 9 in)
height	9.08 m (29 ft 9 in)
wing area	197.04 m² (2,121 sq ft)

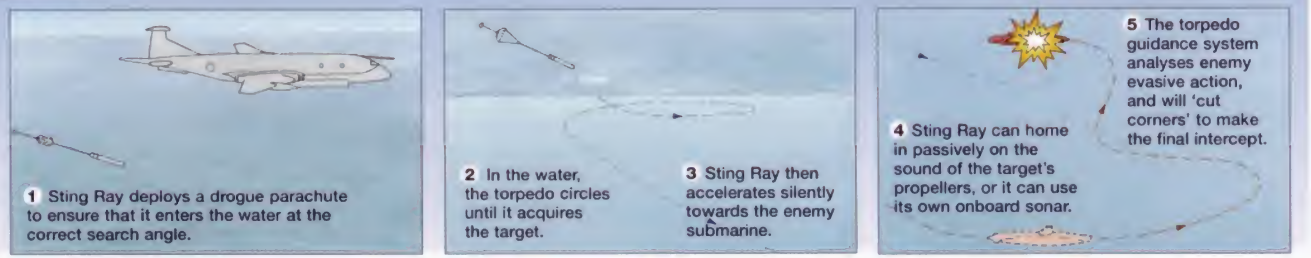
NIMROD MR.MK 2

Entering service in 1969, the Nimrod has seen much service in its long career, from patrolling icy North Atlantic waters to combat in the Falklands and the Gulf.



Sting Ray engagement

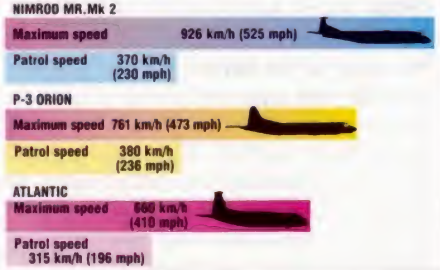
The Nimrod's primary anti-submarine weapon is the Sting Ray lightweight torpedo. Sting Ray can be launched from ships as well as aircraft, and combines a computerized guidance system with a powerful shaped-charge explosive designed to punch through the double hulls of Soviet Cold War-era submarines.



ACTION DATA

MAXIMUM/PATROL SPEED

The Nimrod's jet engines enable it to reach patrol areas faster than any other maritime aircraft. Once there, it can shut down two of its four engines and loiter for up to 15 hours at a time. The American Orion and the Franco/German Atlantic can also stay on station for long periods, but being propeller-driven they lack the Nimrod's ultimate speed and spend much more time in transit.



ILYUSHIN

IL-28 'BEAGLE'

● Early jet bomber ● Torpedo strike ● Middle East war veteran

▲ *Lacking a suitable replacement, China built the Il-28 long after it was obsolete, even exporting one to Albania, where it may still be flying. Like the British Canberra, it survived because large twin-engined jets are extremely useful for tasks such as target towing.*

Still in service half a century after it was designed, the Il-28 was a stunning aircraft when it first flew, the equal of the British Canberra. The 'Beagle' was exported to many nations, and hundreds were based in Warsaw Pact countries. In service with Egypt and Syria, the Il-28 saw action against Israel in 1967, and also fought in Nigeria. Built under licence in China, the Il-28 still flies in very small numbers in support roles.

PHOTO FILE

ILYUSHIN IL-28 'BEAGLE'

Bombsight ▶
The Il-28's bomb-aimer sat in a glazed nose and aimed his weapons visually with an OPB-5S bombsight, set to the right of the cockpit.

▼ Advanced design
Due to the success of the basic design the Il-28 was hardly changed during its career. Unusually, the main wing was unswept, but the tail was swept. In trials, it easily beat the rival Tu-78 prototype.

▼ Indonesian sailor
Torpedo-bombing Il-28s and the training Il-28U were used by Indonesia. The front cockpit accommodated the instructor, who could override his pupil if required.

◀ German Beagle
East Germany used 'Beagles' until the late 1970s. This aircraft has had its 23-mm (0.91-in) tail guns deleted as a weight-saving measure.

▼ African warrior
Nigeria used the Il-28 in its civil war. Poor maintenance meant that the aircraft were grounded for the majority of their lives, and the type has now been retired by all the user nations of Africa.

▲ Czech relic
Known as the B-228 in Czech service, the Il-28 served first as a light bomber, then as a target tug without armament. The wing-tip pods were not always fuel tanks; many Il-28s had ECM equipment fitted in these pods. Il-28s can still be seen at air museums in Prague and Monino, near Moscow.

FACTS AND FIGURES

- Israeli air strikes in the 1967 war claimed many Egyptian and Syrian Il-28s before they had even got off the ground.
- The prototype was initially fitted with Soviet-built Jumo 004 turbojets.
- Aeroflot used civilianized Il-28s (Il-20s) to fly newspaper matrices to Siberia.
- In flight trials against the Tu-78, three randomly picked crews all said they preferred flying the Il-28.
- Albania purchased a single H-5, which may still be flying, from China.
- Il-28Ts carried two 553-mm (21.7 in.) torpedoes in the internal bomb-bay.

PROFILE

Bombing in the 'Beagle'

Ilyushin's Il-28 was the mainstay of the Warsaw Pact tactical bomber force in the early Cold War period. Design began in 1947, benefiting from advanced British engine technology (the Rolls-Royce Nene engine) which had just been sold to the Soviet Union.

The aircraft first flew in 1948, entering squadron service in 1950. More than 1500 had been built by 1955, including minelaying and torpedo-bombing Il-28Ts for the naval air arm (AVMF) and Il-28U conversion trainers. The 'Beagle' was fast and carried an effective warload, including the TN nuclear weapon. The Il-28 reconnaissance version also flew in 1950, followed by the long-range nuclear strike Il-28D and other versions for target towing, electronic warfare and systems development.

The success of the 'Beagle' was widely recognized abroad, with sales to most Eastern bloc states, Egypt, Finland, Indonesia, Somalia and Yemen. China licence-built the Il-28 as the Hongzhaji-5 (H-5) and even exported this version, which remains in service today. Its half-century of service includes action in the Arab-Israeli war of 1967, the Afghan war, and probably in the Iran-Iraq and Somali-Ethiopian wars.

Above: In an effort to get hundreds of Il-28s into service as soon as possible, the airframe was built in sections which were then bolted together.

Above: Had the Cold War ever turned hot, the Il-28 would have been committed in huge numbers, probably armed with tactical nuclear weapons as well as flying electronic warfare and tactical reconnaissance missions.

Il-28 'Beagle'

Type: three-seat twin-jet light bomber, torpedo bomber and reconnaissance aircraft

Powerplant: two 26.87-kN (6,403-lb-thrust) Klimov VK-1 (Rolls-Royce Nene) turbojets

Maximum speed: 900 km/h (559 mph) at 4500 m (14,764 ft)

Initial climb rate: 770 m/min (2,526 fpm) to 5000 m (16,404 ft)

Combat radius: 1135 km (705 miles)

Service ceiling: 12,300 m (40,354 ft)

Weights: empty 12,890 kg (28,418 lb); maximum take-off 23,200 kg (51,147 lb)

Armament: two 23-mm (0.91-in) cannon in nose (fixed) and two in tail turret; 3000 kg (6,614 lb) of bombs

Dimensions:

span	21.45 m (70 ft 4 in)
length	17.65 m (57 ft 11 in)
height	6.70 m (22 ft)
wing area	60.8 m² (654 sq ft)

H-5

Built under licence in China as the H-5, the Il-28 still serves the People's Liberation Army Air Force and Romanian air force. More than 2,000 were built in China and 500 were imported from the Soviet Union.

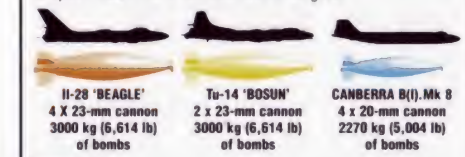
COMBAT DATA

MAXIMUM SPEED

Jet bombers were already travelling much faster than post-war fighters by 1950, making them potentially very difficult to intercept. Great advances in engine technology were the main reason.

WEAPON LOAD

Tactical nuclear payloads were very common for the Canberra, but less so for the Tupolev and Ilyushin, which both had very respectable payloads. The Canberra's gun armament was all forward-facing, as its speed meant that it had little use for tail guns.



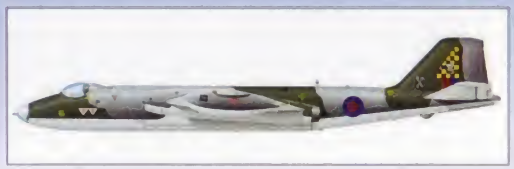
RANGE

The Tu-14 was designed as a naval strike aircraft (albeit operating from land bases and not ships), and therefore had long range. Despite its excellent performance, the Soviets ordered the Il-28 instead. The Canberra and Il-28 were both designed as tactical bombers, and therefore had shorter range. Neither aircraft was refuelled in flight, although the Canberra was able to carry underwing fuel tanks. High fuel consumption was a feature of early jet engines such as the VK-1.

Jet bombers of the 1950s

■ **NORTH AMERICAN B-45 TORNADO:** Using four engines in pairs, the B-45 was an extremely ugly aircraft, but had a long range and heavy payload. Later Tornados had more advanced engines and systems, and the reconnaissance version carried 12 cameras.

■ **ENGLISH ELECTRIC CANBERRA B.Mk 2:** The B.Mk 2, the first operational version of the Canberra, was very successful. Many were based in RAF Germany, armed with tactical nuclear weapons. The B.Mk 6 was essentially the same aircraft with uprated engines.



■ **SUD-OUEST VAUTOUR:** Designed as an all-weather fighter and ground-attack aircraft as well as a light bomber, the Vautour was used with spectacular success by Israel during raids against Arab airfields in 1967, and was only retired in the late 1970s.

ILYUSHIN

IL-38 'MAY'

● Sub hunter ● Maritime patroller ● Based on Il-18 airliner

▲ *The 'May' is one of Russia's two main sub hunters and maritime patrollers. Around 50 are estimated to remain in service with the Russian navy, as well as in India and the Ukraine.*

Just as the American P-3 Orion was developed from the Lockheed Electra and the British Nimrod from the de Havilland Comet, the Soviet Il-38 was derived from the Il-18, an airliner and military transport that first flew in 1957. The 'May' has a longer fuselage and the wings are mounted farther forward. Stores bays are ahead of and behind the wing structure and there is a long magnetic anomaly detector (MAD) stinger extending from the tail.

PHOTO FILE

ILYUSHIN IL-38 'MAY'

▼ Airliner roots
Like its Western counterparts, the Nimrod and Orion, the Il-38 is developed from an airliner, the 122-seat Il-18 "Coot."

▲ Deployment
'Mays' have been deployed under Soviet control all over the world, from the Baltic, to Yemen, Libya, Syria, northern Asia, Vietnam and Egypt.

▼ 'May' in the tropics
The only export customer has been the Indian navy. Entering service in 1977 with No. 315 Squadron was the first of five Il-38s. These are based at INS Hansa, at Dabolim. Interestingly, India also operates eight Tu-142 'Bear-Fs'.

▲ Shadowing the US fleet
An A-6 Intruder intercepts a snooping 'May'. One of the Il-38's missions is to keep a close watch on the activities of U.S. Navy carrier battle groups.

◀ Caught in the act
A Swedish interceptor snaps an Il-38 dropping a sonobouy. The 'May' carries two types of this acoustic sensor: passive and active. Ejected in a predetermined pattern, they are designed to pinpoint the location of hostile submarines.

FACTS AND FIGURES

- In order to adjust the center of gravity of the heavier Il-38 compared to its parent Il-18, the wings are set farther forwards.
- Yemen and the former USSR signed a treaty allowing 'Mays' to fly from Yemen.
- Four pressure refueling points serve the Il-38's 30,000-litre (7,926-gal.) fuel tanks.
- Shrouded in secrecy for some time was the conversion of 22 'Mays' to airborne command posts as the Il-20 'Coot-B'.
- The Il-20 'Coot-A' is an electronic intelligence rebuild of the Il-38.
- Eight engine-driven generators supply electrical power for the avionics.

PROFILE

Soviet eye above the seas

As well as the tail-mounted MAD sensor, which detects the small variations in the earth's magnetic field caused by passing submarines, the 'May' carries a big 'Wet Eye' search radar under the forward fuselage. It can remain on patrol for up to 12 hours at a time, fly at speeds as low as 190 km/h (118 m.p.h.), and land in as little as 850 m (2,790 ft.) using reverse thrust from its propellers.

In addition to the two pilots and flight engineer on the flight deck, the aircraft carries a crew of nine systems operators in the main cabin. Their job is to monitor the displays showing targets detected by the radar and MAD sensors, and to track submarines using sonobuoys dispensed from the stores bays. Contacts may be destroyed using depth charges, torpedoes or missiles.

Only one export customer for the 'May' was found and a handful of Il-38s are operated by the Indian navy's No. 315 Squadron from its base at Dabolim. Before the Soviet Union disintegrated, 'Mays' were also deployed to bases in Yemen, Libya and Syria. And during the early 1970s, Soviet aircraft were flown in Egyptian markings from bases located in Egypt.

The bulk of the former Soviet Il-38s (about 59 aircraft in 1993) remain in service with the AV-MF, the air arm of the Russian navy. Lack of significant upgrades for the 'May' and continuing production of the Tu-142 seem to indicate that the latter is Russia's preferred maritime patrol and ASW aircraft.

Il-38 'May'

Type: medium-range anti-submarine and maritime patrol aircraft

Powerplant: four 3169-kW (4,250-hp.) ZMDB Progress AI-20M turboprops

Maximum speed: 722 km/h (448 m.p.h.) at 6400 m (21,000 ft.)

Take-off run: 1300 m (4,264 ft.)

Endurance: 12 hours

Weapons: Attack weapons and sonobuoys carried in two lower-fuselage bays.

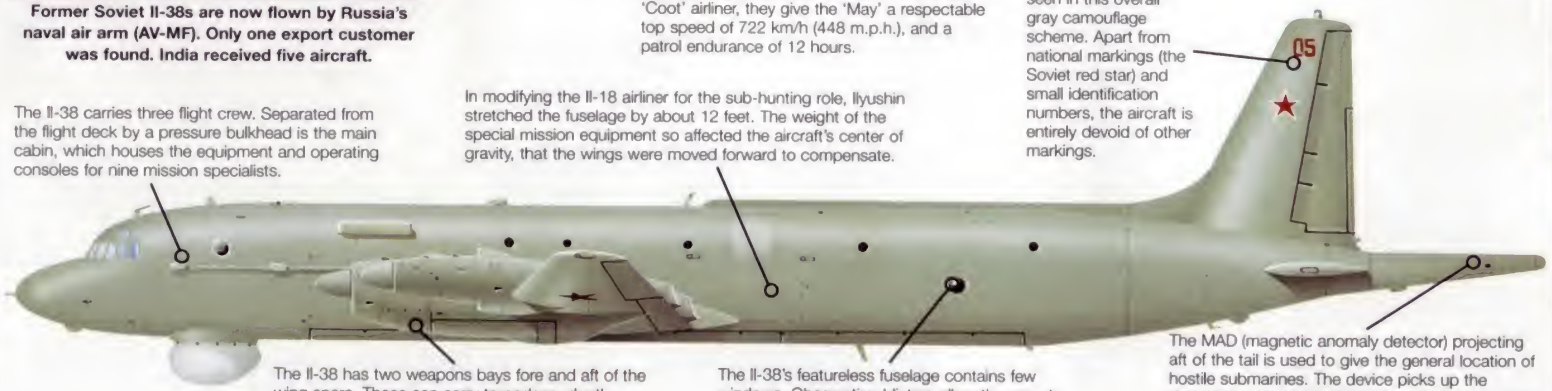
Weight: 63,500 kg (140,000 lb.) max. take-off

Dimensions:

span	37.42 m (122 ft. 9 in.)
length	39.60 m (131 ft.)
height	10.16 m (133 ft. 4 in.)
wing area	140 m² (1,506 sq. ft.)

IL-38 'MAY'

Former Soviet Il-38s are now flown by Russia's naval air arm (AV-MF). Only one export customer was found. India received five aircraft.



ACTION DATA

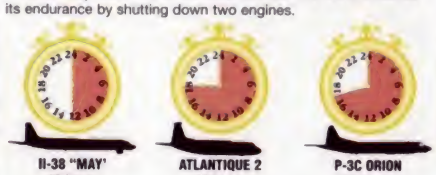
SPEED

Maritime patrol aircraft frequently have to reach a distant part of the ocean quickly, perhaps to check a contact or to assist in a rescue. The P-3C arrives first, but the Il-38 is not far behind.

Il-38 'MAY'	722 km/h (448 m.p.h.)
ATLANTIQUE 2	648 km/h (402 m.p.h.)
P-3C ORION	761 km/h (472 m.p.h.)

ENDURANCE

Patrol aircraft must spend a long time on station. The less fuel-efficient 'May' loses out to the other aircraft. The Orion achieves its endurance by shutting down two engines.



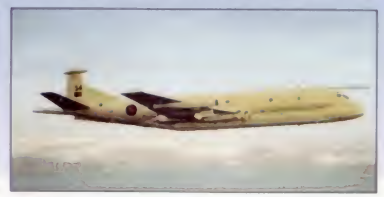
WEAPONS

Having found an enemy target, it must be destroyed with depth charges, torpedoes or missiles. The smaller load of the Il-38 relates to its lack of external weapons stowage.

From airliner to maritime patroller

■ **PILATUS BRITTEN-NORMAN MARITIME DEFENDER:** This version of the original Islander has proved popular with smaller air forces.

■ **BRITISH AEROSPACE NIMROD:** Developed from the world's first jet airliner, the superb Nimrod will serve for many years to come.



■ **LOCKHEED CP-140 AURORA:** Lockheed redesigned the Electra to build the Orion and Canada adopted its own CP-140 variant.

■ **AIRTECH (CASA/IPTN) CN-235 MPA:** In competition with the Maritime Defender, this more modern aircraft is becoming popular.

ILYUSHIN

IL-76 'CANDID'

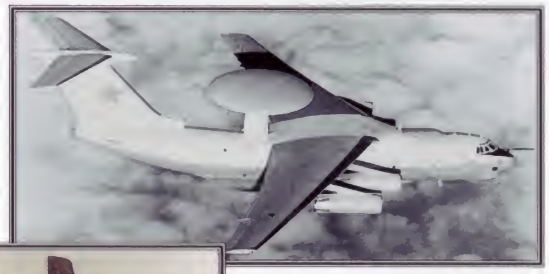
● Tactical transport ● Strategic airlift ● Airborne command post

▲ *Like most Soviet aircraft, the Il-76 is extremely rugged; in the words of an RAF C-130 pilot, 'the thing is built like a bridge'. It remains the principal equipment of the Russian military transport force.*

Capable of carrying a 40-tonne (44-ton) payload onto a battlefield airstrip, the massive Il-76 is one of the world's most impressive transports. Even larger than the Lockheed StarLifter, the Il-76 has short-field capability, long range and can carry huge loads. Despite being designed for the military transport role, the Il-76 has also been converted into an airborne command post and a water-bomber, and is also used by many civilian operators.

PHOTO FILE

ILYUSHIN IL-76 'CANDID'

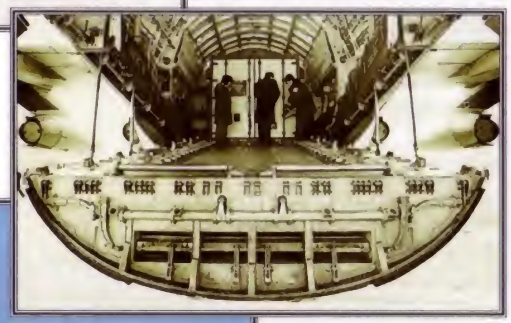


▲ Para drop
The Soviet army's paratroop force relies on the Il-76M to go to war. The aircraft can deploy 125 fully equipped paratroops at a time. They exit the aircraft over the rear ramp to avoid the engine efflux.

▲ Early warning
The Il-76 carried out trials for the Soviet Il-78 'Midas' airborne early warning aircraft, which is comparable to the Boeing E-3.

◀ Record breaker
An Il-76 flew a 60-tonne (66-ton) payload for 2000 km (1,243 miles) at 875 km/h (544 mph) in 1975.

▼ Aeroflot colours
Despite its airline colour scheme, the Il-76 was mostly dedicated to military service; many Aeroflot aircraft flew to Kabul in Afghanistan to offload Soviet garrison troops.



▲ Ramp loading
Unlike most of the An-12s it was designed to replace, the Il-76 has an integral rear door and ramp for fast loading.

FACTS AND FIGURES

- The Il-76 has been exported to Algeria, China, Cuba, Hungary, India, Iraq, Libya, North Korea and Syria.
- In Indian service the Il-76 is called 'Gajaraj' (cock elephant).
- The new Il-76MF, carrying a 52,000-kg (114,640-lb) payload, first flew on 1 August 1995.
- The Il-76MDK allows trainee cosmonauts to experience weightless conditions.
- The basic 'Candid' can be converted into the Il-76DMP firefighting platform, carrying 42,000 litres (11,095 US gal) of water or retardant.
- The Il-76 transport can airdrop light tanks, pallets and amphibious vehicles.

PROFILE

Russia's military heavyweight lifter

Designed to replace the turboprop An-12, Ilyushin's Il-76 first flew in 1971 and entered service with a development squadron in 1974. Series production began in 1975 in Tashkent; by 1993 more than 750 had been built, with production then continuing at the rate of one aircraft per week.

Immensely strong, the Il-76 has a titanium floor in the hold, a multi-wheel undercarriage, a wing fitted with various high-lift devices and four powerful Lotarev turbofans to allow short take-offs from rough airstrips. The 'TD' variant has uprated engines for 'hot-and-high' performance; other Il-76s have been converted for airborne early warning and as command and control aircraft and tankers.

Military Il-76s differ from their civilian brothers by having a prominent rear gun turret with two 23-mm (0.91-in) cannon, chaff and flare dispensers, and small fairings for electronic countermeasures gear. Delays in the An-70 programme mean that the Il-76 remains vital to the Russian tactical airlift force.

An adaptable aircraft, the Il-76 has also found use with Aeroflot as a freight transport and airliner. At least one, equipped with buffet kitchen, sleeping area and various cold-weather modifications is used in support of Russian Antarctic operations.

Il-76M 'Candid-B'

Type: medium military transport, command post, tanker (Il-78) and AEW aircraft (A-50)

Powerplant: four 117.68-kN (26.468-lb-thrust) PNPP Soloviev D-30KP-1 turbofans

Maximum speed: 850 km/h (528 mph)

Maximum cruising speed: 800 km/h (497 mph) at 12,000 m (39,370 ft)

Range: 5000 km (3,107 miles) with maximum payload of 40,000 kg (88,185 lb)

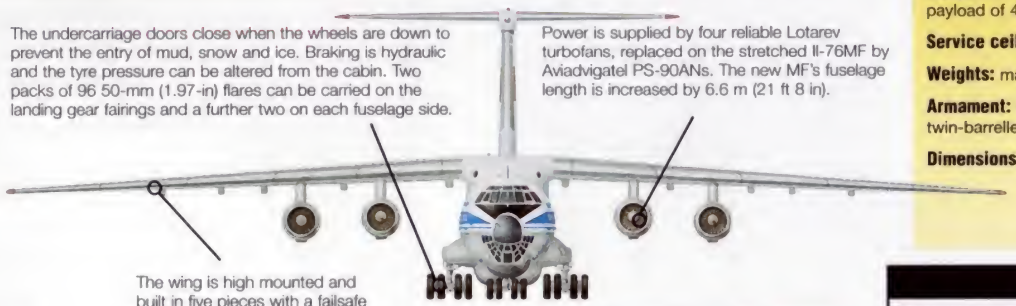
Service ceiling: 15,500 m (50,853 ft)

Weights: maximum take-off 190,000 kg (418,878 lb)

Armament: optional two 23-mm GSh-23L twin-barrelled cannon in tail turret

Dimensions:

span	50.50 m (165 ft 8 in)
length	46.59 m (152 ft 10 in)
height	14.76 m (48 ft 5 in)
wing area	300.00 m² (3,229 sq ft)



The undercarriage doors close when the wheels are down to prevent the entry of mud, snow and ice. Braking is hydraulic and the tyre pressure can be altered from the cabin. Two packs of 96 50-mm (1.97-in) flares can be carried on the landing gear fairings and a further two on each fuselage side.

Power is supplied by four reliable Lotarev turbofans, replaced on the stretched Il-76MF by Aviadvigatel PS-90ANs. The new MF's fuselage length is increased by 6.6 m (21 ft 8 in).

The wing is high mounted and built in five pieces with a failsafe multi-spar construction.

Il-76TD 'Candid'

The Russian air force operates around 300 Il-76 transports, plus an additional number of testbeds, labs, AEW aircraft, tankers, Il-76VPK naval command posts and various electronic aircraft.

The cockpit seats a crew of seven, including two freight handlers. The glazed nose houses a navigator for negotiating combat landings without the use of the chin radar. All systems are designed for all-weather, day or night operations.

The 'Candid' has a hold with reinforced titanium flooring and folding roller conveyors. In the roof are two travelling lifter cranes each with two hoists of 2500-kg (5,512-lb) capacity. At the front of the hold are twin winches for loading cargo. The hold can accommodate up to three specially designed modules for medical evacuation, passenger transport, supply or maintenance.

The large fuselage hold is fully pressurized and accommodates 140 troops or 125 armed paratroops. Alternatively freight containers, cranes, trucks, APCs, artillery or light tanks can be carried.

The tail ramp can be used as an additional hoist, with a 30,000-kg (66,139-lb) capacity for loading heavier caterpillar-tracked vehicles.

The military-tasked Il-76 generally carries a tail turret containing two 23-mm (0.91-in) twin-barrelled guns.

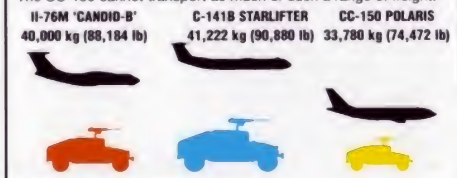
COMBAT DATA

MAXIMUM CRUISING SPEED

The C-141 is more streamlined and can cruise at a higher speed than the Il-76. The Polaris is based on the A310 airliner design. All three would usually cruise at between 800 and 880 km/h (497 and 547 mph).

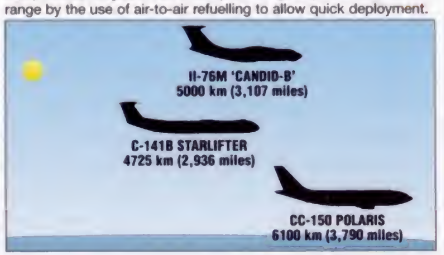
PAYLOAD

The StarLifter and Il-76 are of similar design and perform similar tasks, both being able to carry around 40,000 kg (88,184 lb) of cargo. The CC-150 cannot transport as much or such a range of freight.



RANGE WITH PAYLOAD

The Il-76 and StarLifter are used to transport troops and equipment on a global scale. They both regularly extend their range by the use of air-to-air refuelling to allow quick deployment.



Red star airlifters

■ **ILYUSHIN Il-14 'CRATE':** Although now thoroughly obsolete, the Il-14 enjoyed great success as the standard Eastern Bloc military transport aircraft throughout the 1950s and 1960s.

■ **ANTONOV An-26 'CURL':** Derived from the An-24, the An-26 is a very successful transport aircraft which has found widespread use in both military and civilian markets.

■ **ANTONOV An-72 'COALER':** This turbofan-powered STOL transport was designed to replace the turboprop An-26. It can carry freight, troops or paratroops, with entrance via a rear ramp.

LOCKHEED

F-80 SHOOTING STAR

● First US jet in combat ● First jet-versus-jet dogfights ● Close support

Russell J. Brown, a 1st Lieutenant flying a USAF Lockheed F-80 Shooting Star, achieved history's first jet-versus-jet aerial victory on 8 November 1950. After flying a defence suppression mission in support of a B-29 raid, Brown engaged a MiG-15. He suffered a 'jam' of all but one of his F-80's six 12.7-mm (0.5-in) machine guns. Using that single gun, diving towards the enemy over North Korea, Brown fired, saw flames erupt and the MiG go down.

▲ *With the introduction of the MiG-15, Shooting Star pilots struggled in air-to-air combat, although their superior training often gave them a decisive advantage. The F-80 was a strong machine, capable of getting back to base after absorbing damage.*

PHOTO FILE

LOCKHEED F-80 SHOOTING STAR

▼ Outdoor servicing
Conditions in Korea were very basic, with most maintenance taking place on the flight line.

▼ Area attack
This F-80 carries four napalm tanks – a fearsome weapon which spreads destruction over a wide area.

▲ Shooting Star study
A sleek, highly successful jet, the F-80 was designed and built in 143 days. Initially based around British engine technology, the aircraft went on to be developed into an interceptor and a line of best-selling military trainers.

Napalm strike ▶
When dropped accurately from low level, napalm was devastating against 'soft' targets such as vehicles and personnel.

▲ Rocket assistance
A heavily laden F-80 lifts off using rocket assistance. Many muddy Korean airfields were covered with pierced steel planking.

FACTS AND FIGURES

- Before the arrival of the MiG-15s in November 1950, F-80s shot down 11 propeller-driven warplanes.
- On 17 March 1951, 1st Lieutenant Howard J. Landry scored the second F-80 MiG kill.
- Lockheed manufactured 1732 F-80s, including reconnaissance versions.
- In Korea, F-80s flew 98,515 combat sorties, shot down 37 enemy aircraft and fired 80,935 rockets.
- The third F-80-versus-MiG-15 victory was achieved on 29 July 1951.
- Initially, experienced Soviet pilots flew MiG-15s during the Korean War.

PROFILE

East-West jet combat over Korea

Only three aerial victories by the Lockheed F-80 Shooting Star against the MiG-15 are recognized by the US Air Force. Many believe that the real total is five, two of which were not officially credited. This modest tally of air-to-air successes is a sideline to the role performed by the F-80 as a record-setter in the 1940s and a fighter-bomber in the 1950–53 Korean conflict. But for the F-80 pilots who fought the vaunted MiG-15, these actions were the height of adventure.

With its straight wing and machine-gun armament, the F-80 was not considered a match for the swept-wing, cannon-equipped MiG. The F-80 was manoeuvrable and durable, however, and by no means easy to defeat.

On each occasion when the Shooting Star and MiG came up against each other, the F-80 pilot had travelled far from his home base, was preoccupied with evading ground fire to bomb a target, and became caught up in a dogfight as a major distraction from his assigned mission. In contrast, the MiG-15 pilot had no other mission, was close to home and was flying over his own territory. The ability of the F-80 to defeat his adversary in a MiG was a tribute to his training and tenacity.

Armed with two 227-kg (500-lb) bombs, these F-80s head out for a close-support mission. The F-80 proved to be a capable attack aircraft.

F-80C SHOOTING STAR

Captain Francis B. Clark of the 35th Fighter-Bomber Squadron destroyed a Yak-9 and damaged another in this F-80 on 19 July 1950.

Most of the design features of this first-generation jet fighter were very simple, including the conventional tail layout.

With the original 625-litre (165-US gal) tip-tanks not providing sufficient range, local ingenuity produced a 757-litre (200-US gal) fuel tank. Some aircraft were also modified to carry 10 127-mm (5-in) rockets.

The blown canopy gave the pilot excellent visibility in combat. Ventilation was inadequate, however, and the cockpit often became very hot.

By dispensing with a propeller, designers could make use of much shorter, stronger undercarriage legs. These, together with the nosewheel landing-gear configuration, gave the jets excellent ground handling, but the early jet engines were sometimes temperamental in the harsh conditions of Korea.

Six 12.7-mm (0.5-in) Colt-Browning machine guns were the primary air-to-air armament. While not as powerful as the MiG-15's guns, they were more accurate.

Shooting Stars were ruggedly constructed, with many surviving stresses of up to 13 *g* when pulling out of dives. Hits from 40-mm (1.57-in) anti-aircraft guns could be absorbed.

The entire rear fuselage had to be removed for access to the engine. The majority of servicing occurred on muddy airstrips.

Unusually for an early jet design, the F-80 had a considerable distance between its intakes and exhaust. Surprisingly, thrust loss did not appear to be a problem.

F-80C Shooting Star

Type: single-seat fighter

Powerplant: one 24-kN (5,398-lb-thrust) Allison J33-A-35 turbojet engine

Maximum speed: 956 km/h (594 mph) at sea level

Cruising speed: 902 km/h (560 mph) at sea level

Range: 1328 km (825 miles)

Service ceiling: 14,265 m (46,800 ft)

Weights: empty 3819 kg (8419 lb); maximum take-off 7646 kg (16,857 lb)

Armament: six 12.7-mm (0.5-in) forward-firing nose-mounted Browning M3 machine guns plus two 454-kg (1,000-lb) bombs or napalm tanks and eight HVAR (high-velocity aircraft rockets) mounted under the wings

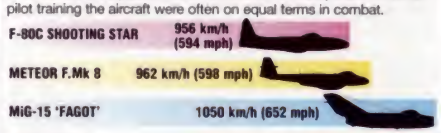
Dimensions:

span	11.81 m (38 ft 9 in)
length	10.49 m (34 ft 5 in)
height	3.43 m (11 ft 3 in)
wing area	22.07 m² (238 sq ft)

COMBAT DATA

MAXIMUM SPEED

Swept wings gave the MiG-15 good performance even with moderate thrust. It could outperform the F-80, but due to competent American pilot training the aircraft were often on equal terms in combat.

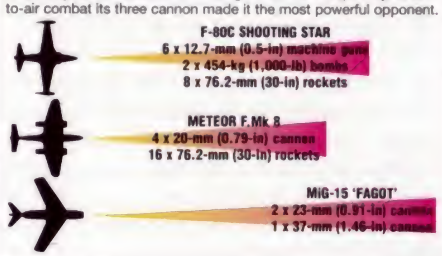


THRUST

In its later F.Mk 8 form, fitted with Derwent engines, the Meteor was powerful. Although its power and rugged construction suited it well to the ground-attack role, it did not perform well as a fighter in Korea.

ARMAMENT

While the F-80 and Meteor were excellent ground-attack aircraft as well as fighters, the MiG-15 had no ground-attack capability. In air-to-air combat its three cannon made it the most powerful opponent.



US jets over Korea

DOUGLAS F3D SKYNIGHT: Flown in the night-fighter role from US carriers, this straight-winged fighter achieved a MiG-15 kill and the world's first beyond-visual-range kill.

GRUMMAN F9F PANTHER: Used mostly for close support, powerfully armed Panthers destroyed a number of MiGs in air-to-air combat with their four 20-mm (0.79-in) cannon.

NORTH AMERICAN F-86 SABRE: The ultimate MiG-killer of the Korean War, the F-86 was steadily developed to counter the MiG-15's superior qualities.

REPUBLIC F-84 THUNDERJET: Rapidly nearing obsolescence by the time of the Korean conflict, the F-84 was used exclusively in the ground-attack role.

LOCKHEED

F-94 STARFIRE

● All-weather interceptor ● Cold War defender ● T-33 development

▲ *For more than three years, from late 1949 until 1953, the F-94 was the USAF's only all-weather jet fighter. As such, it played a vital part in the Cold War, protecting the United States from a perceived Soviet threat.*

In the 1950s the Lockheed F-94 Starfire was the first jet aircraft to combine weaponry with an air-to-air radar set. The F-94 was the USAF's first jet-powered, all-weather interceptor. This fighter, with its crew of pilot and radar operator, saw useful service in the Korean conflict (1950–53), but its reputation was made in guarding the North American continent from the threat of bomber attack during the volatile Cold War.

PHOTO FILE

LOCKHEED F-94 STARFIRE

▲ **Swept tailplane**
The modified tailplane of the F-94C is obvious here. Starfires devoid of rocket pods but carrying wingtip tanks were introduced from the 100th aircraft.

▲ **First prototype**
Modified from a TF-80C Shooting Star (later known as the T-33A), the first two YF-94s lacked some operational equipment and were used as test aircraft.

▲ **From F-97A to F-94C**
Initially designated F-97A due to an extensive redesign, 387 examples of the improved variant were delivered as F-94Cs between 1951 and 1954. The last examples were retired in 1959.

▲ **Rippling rockets**
An F-94C fires a salvo of highly accurate 70-mm (2.76-in) 'Mighty Mouse' rockets from its wing pods.

Afterburner aglow ▶
Radar and armament added considerable weight to the F-94, and an afterburner was essential to maintain performance.

FACTS AND FIGURES

- The F-94 was the world's first two-seat combat aircraft to exceed the speed of sound in a dive.
- The YF-94 prototype, piloted by Tony LeVier, first flew on 16 April 1949.
- The first 17 production F-94As were modified from T-33 airframes.
- The shootdown of an La-9 on 30 January 1953 was the first air victory achieved solely on cockpit instruments.
- In all, 854 Lockheed F-94 interceptors were built between 1948 and 1952.
- The F-94C became the first production fighter to use a braking parachute.

PROFILE

America's Cold War defender

When the Lockheed F-94 Starfire began to reach Air Defense Command squadrons in the early 1950s, many thought that it looked familiar. This was because the F-94 was a development of the Lockheed F-80 Shooting Star, the first operational US jet fighter. The F-80 also gave its design features to the famous T-33 trainer, the 'T-bird', from which the F-94 was derived.

The F-94 Starfire all-weather interceptor was created by adding radar, fitting a rear-seat observer and equipping the aircraft to detect and intercept approaching bombers.

The F-94 was rushed to Japan for action when it became clear that the enemy was employing both prop and jet warplanes in an effort to control the night sky. At the time, the F-94's radar was considered so secret that aircraft were not allowed to fly beyond enemy lines – but they still managed to down several warplanes. F-94s also served with more than two dozen air defence squadrons in the United States and Alaska. When sent aloft to intercept a bomber, the F-94 was given directions by a ground control intercept (GCI) operator using ground-based radar, as the aircraft's air-to-air radar was useful only over a distance of about 32 km (20 miles). Replaced by supersonic interceptors, the F-94 was retired less than a decade after it entered service.

The earlier-production F-94B bore a stronger resemblance to the TF-80C (later redesignated T-33) from which it was developed. The F-94C introduced a swept tailplane, a broader rear fuselage and wing-mounted rocket pods.

F-94B Starfire

Type: two-seat all-weather interceptor

Powerplant: one 26.69-kN (6,0003-lb-thrust) Allison J33-A-33 afterburning turbojet

Maximum speed: 975 km/h (606 mph) at sea level

Cruising speed: 727 km/h (452 mph) at sea level

Initial climb rate: 2088 m/min (6,850 fpm)

Maximum range: 1455 km (904 miles)

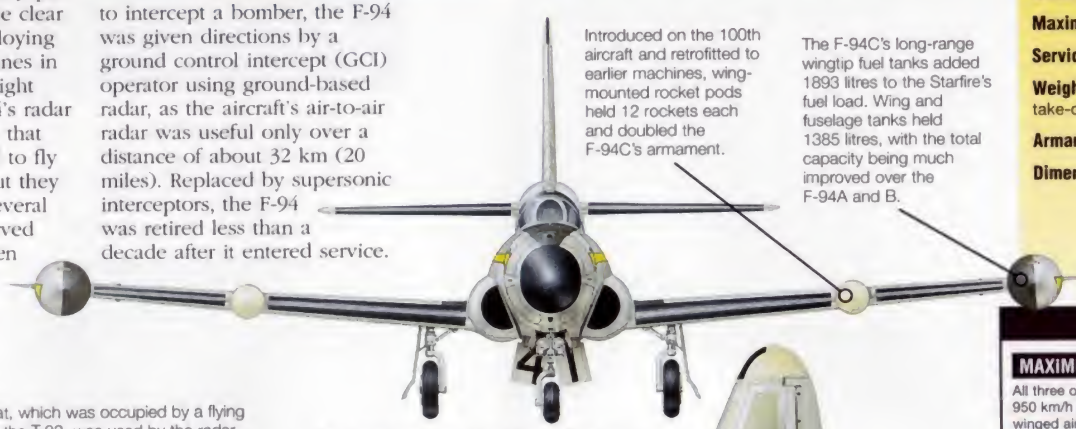
Service ceiling: 14,630 m (48,000 ft)

Weights: empty 4565 kg (10,064 lb); maximum take-off 7640 kg (16,843 lb)

Armament: four 12.7-mm (0.5-in) machine guns

Dimensions:

span	11.86 m (38 ft 11 in)
length	12.22 m (40 ft 1 in)
height	3.86 m (12 ft 8 in)
wing area	21.81 m² (235 sq ft)



Introduced on the 100th aircraft and retrofitted to earlier machines, wing-mounted rocket pods held 12 rockets each and doubled the F-94C's armament.

The F-94C's long-range wingtip fuel tanks added 1893 litres to the Starfire's fuel load. Wing and fuselage tanks held 1385 litres, with the total capacity being much improved over the F-94A and B.

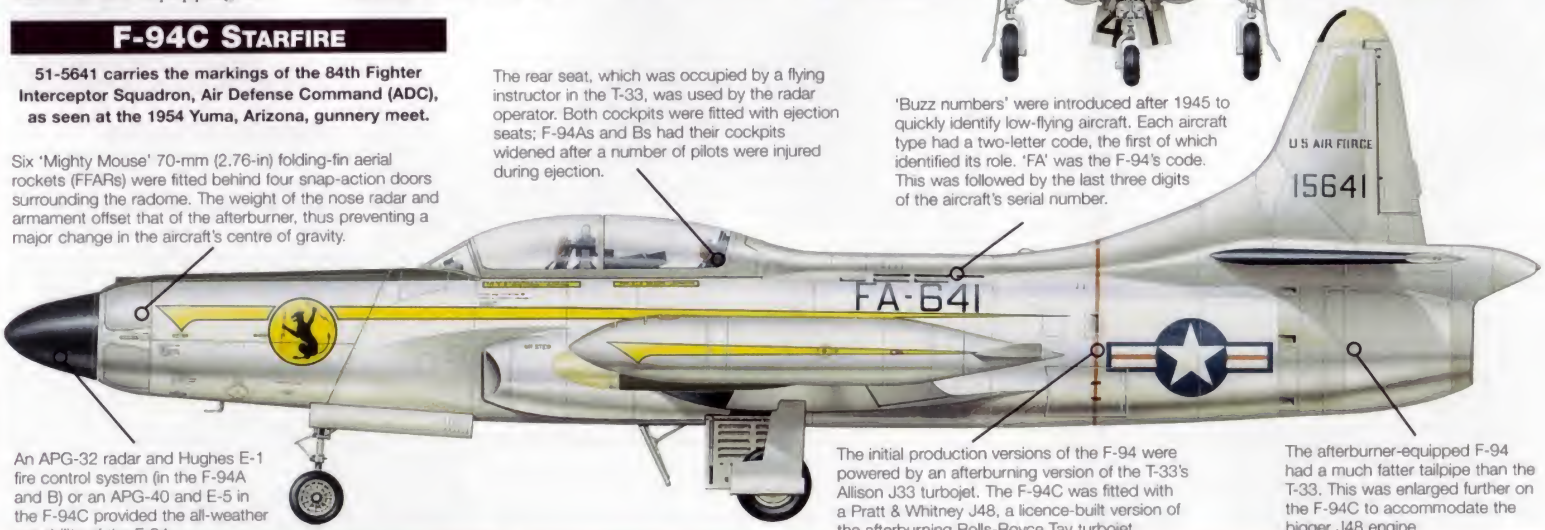
F-94C STARFIRE

51-5641 carries the markings of the 84th Fighter Interceptor Squadron, Air Defense Command (ADC), as seen at the 1954 Yuma, Arizona, gunnery meet.

Six 'Mighty Mouse' 70-mm (2.76-in) folding-fin aerial rockets (FFARs) were fitted behind four snap-action doors surrounding the radome. The weight of the nose radar and armament offset that of the afterburner, thus preventing a major change in the aircraft's centre of gravity.

The rear seat, which was occupied by a flying instructor in the T-33, was used by the radar operator. Both cockpits were fitted with ejection seats; F-94As and Bs had their cockpits widened after a number of pilots were injured during ejection.

'Buzz numbers' were introduced after 1945 to quickly identify low-flying aircraft. Each aircraft type had a two-letter code, the first of which identified its role. 'FA' was the F-94's code. This was followed by the last three digits of the aircraft's serial number.



An APG-32 radar and Hughes E-1 fire control system (in the F-94A and B) or an APG-40 and E-5 in the F-94C provided the all-weather capability of the F-94.

The initial production versions of the F-94 were powered by an afterburning version of the T-33's Allison J33 turbojet. The F-94C was fitted with a Pratt & Whitney J48, a licence-built version of the afterburning Rolls-Royce Tay turbojet.

The afterburner-equipped F-94 had a much fatter tailpipe than the T-33. This was enlarged further on the F-94C to accommodate the bigger J48 engine.

COMBAT DATA

MAXIMUM SPEED

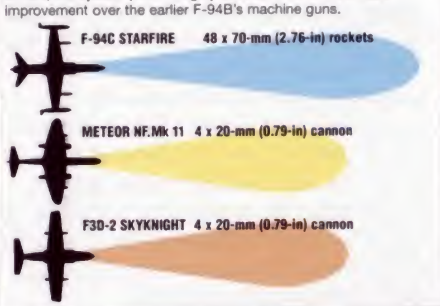
All three of these jet designs were capable of speeds around 950 km/h (590 mph) – about the maximum speed of straight-winged aircraft. All subsequent designs had swept wings.

RANGE

By the time the Meteor night fighters were produced, their airframes were reaching the outer limits of development. Consequently, the aircraft was limited in its fuel capacity and its engines were outdated. Both of these factors affected its range performance.

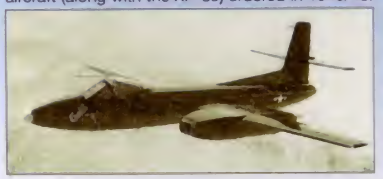
ARMAMENT

Once teething problems with the F-94C's rocket armament were solved, the system proved highly accurate and was a major improvement over the earlier F-94B's machine guns.



The USAF's first all-weather jets

■ **CURTISS XP-87 BLACKHAWK:** Cancelled in 1948, the XP-87 was one of two all-weather aircraft (along with the XP-89) ordered in 1945/46.



■ **NORTHROP F-89 SCORPION:** As a result of teething problems, the F-89 did not enter service until 1952.

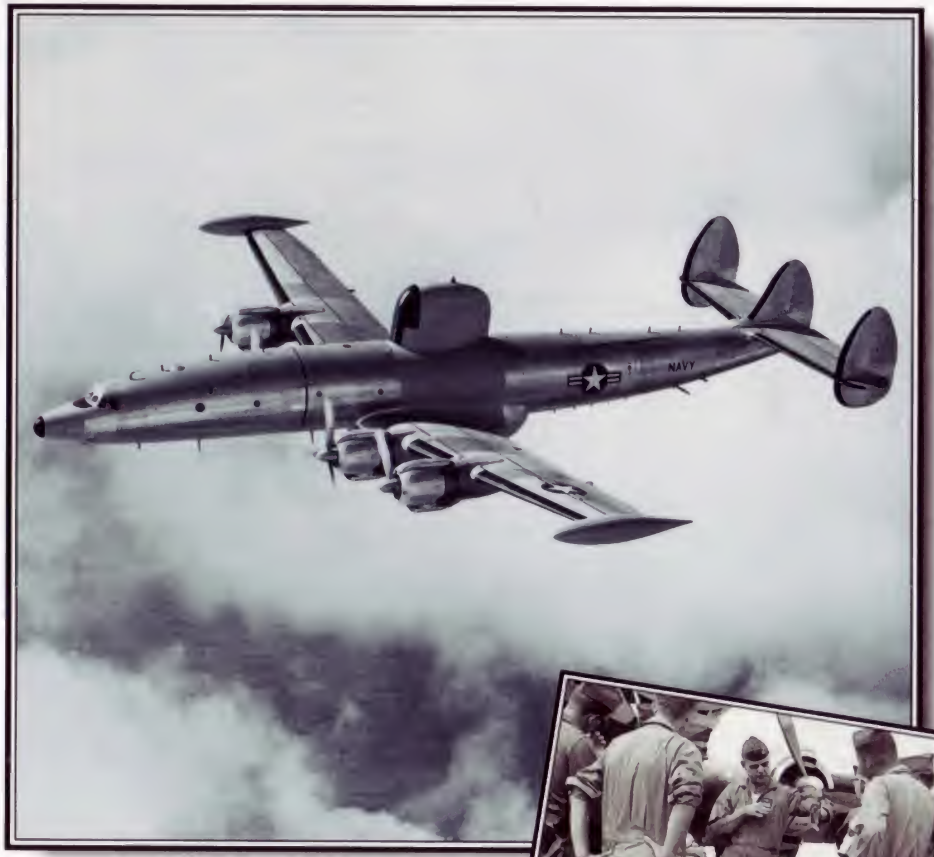
■ **DOUGLAS F3D SKYKNIGHT:** The US Navy's F3D was inconclusively evaluated to fill the gap created by problems with the XP-87 and F-89.

■ **NORTH AMERICAN F-86D SABRE:** While the F-94 was an interim solution, the radar-equipped 'Sabre Dog' served from 1951 to 1965.

LOCKHEED

EC-121 WARNING STAR

● Airborne early warning ● Fighter controller ● Cold War warrior



Combining the elegance of the Super Constellation with the bumps and bulges created by ungainly radar equipment gave America the EC-121, Lockheed's flying radar station. The EC-121 Super Constellation (also known by a number of other military designations) guarded the US coastline in the 1950s and fought in Vietnam in the 1960s. It was the forerunner of today's airborne warning and control system (AWACS).

▲ *A victorious Phantom pilot explains to the crew of an EC-121 how he got a MiG 'kill' over North Vietnam thanks to their direction. Warning Stars performed a key role in the war.*

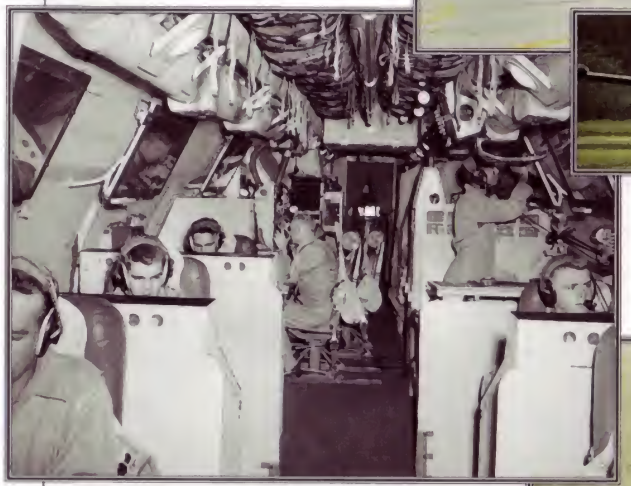
PHOTO FILE

LOCKHEED EC-121 WARNING STAR

◀ Standing guard
Painted in dull blue-grey, a US Navy WV-2 flies another long patrol over the world's oceans, searching for activity.

▼ Still graceful
At the start of its service, the Constellation was one of the most elegant aircraft in the US inventory. Despite the additional radomes, its beauty was still evident.

▼ Radar specialists
Intelligence operators gather information from within the confines of a Warning Star. The limited amount of space is clearly seen.



▲ Operation College Eye
During the Vietnam War, EC-121s operated as flying radar stations and airborne control platforms, offering assistance to any combat aircraft.

Combined operations ▶
Flying over a US carrier, the Warning Stars would often direct fighters from the ship to intercept approaching aircraft. Being airborne increased the radar detection range.

FACTS AND FIGURES

- Warning Stars were operated by the United States to provide early warning of approaching enemy aircraft.
- US Navy Warning Stars were the first examples in service, in October 1955.
- EC-121s flew weather reconnaissance missions until the early 1970s.
- During the air war in Vietnam, Warning Stars acted as fighter controllers, directing US jets towards the MiGs.
- Operations were flown from bases ranging from the Caribbean to Iceland.
- The last EC-121s were retired from USAF service in 1979.

PROFIL

Lockheed's graceful observer

With the beautiful shape of the Lockheed Super Constellation and the miracle of electronic gadgetry, the EC-121 Warning Star became one of the most important aircraft of the 1950s and the subsequent Vietnam War. The four-engined, low-wing Super Constellation carried technical specialists aloft on marathon patrols, searched the skies for enemy aircraft, and guided friendly fights into action against them.

The US Navy and US Air Force employed these fine aircraft as part of the United States' warning system for home defence and also in other corners of the world. Although the main purpose of the EC-121 was air warning and control, some of these aircraft were used to carry out other duties, including electronic reconnaissance. The only one ever lost in action was shot down on a reconnaissance flight near North Korea in 1969, with the loss of its 21-member crew.

In the 1970s, the EC-121 was replaced by Boeing's E-3 AWACS. Warning Stars can still be seen gracing the skies of the United States thanks to two fully restored examples.

Above: Wearing prominent Day-Glo rescue marking, this EC-121D lifts off for another patrol over the Arctic.

Right: Coming into land at Nellis AFB, Nevada, is this fully restored Warning Star. Privately owned, this aircraft is flown at airshows across the United States.

EC-121D Warning Star

Type: airborne early warning aircraft

Powerplant: four 2535-kW (3,400-hp) Wright R-335-34 radial piston engines

Maximum speed: 516 km/h (321 mph) in 6095 m (20,000 ft)

Endurance: up to 35 hours

Initial climb rate: 258 m/min (846 fpm)

Combat range: 7400 km (4,598 miles)

Service ceiling: 6280 m (20,604 ft)

Weights: empty 36,565 kg (80,612 lb); loaded 65,136 kg (143,600 lb)

Accommodation: five crew and 28 mission specialists

Dimensions:

span	37.49 m (123 ft)
length	35.54 m (116 ft 7 in)
height	8.23 m (27 ft)
wing area	153.29 m² (1,650 sq ft)

Despite the long-standing patrols that had to be maintained during operational flights, the Warning Star retained all the comforts of the airliner on which it was based. Crews found the flight deck roomy and well suited to the mission. Positioned behind the two pilots was the flight engineer and, farther back, the navigator and radio operator were situated.

Seated in the fuselage in two rows were electronics operators who collected and correlated the information received by the Warning Star's radar. During missions the radar specialists were able to supply information to other friendly aircraft and ships in the area.

WV-2 Warning Star

Designed from the outset as an early warning aircraft, the WV-2 was officially named the Warning Star, although 'Willy Victor' was the more common nickname. This example operated with the US Navy, and was deployed to numerous overseas bases during the 1960s, before finally being retired in 1965.

Four squadrons were equipped with WV-2s. They maintained constant patrols over the North Atlantic, operating from bases in Iceland and Scotland. In September 1952, the WV-2s were redesignated EC-121Ks, in line with the USAF's designations.

One of the main reasons for the adoption of the Constellation as a radar warning aircraft was the need to position a radome on the underside of the fuselage. Adequate ground clearance was available on the Constellation because of its long undercarriage. This feature and the Constellation's long-range performance made the C-121 an ideal choice.

The rear of the aircraft was devoted to the crewmembers' comfort because of their large number. Four bunks and a toilet were positioned in the extreme rear of the fuselage. Meals could be prepared, reducing the fatigue or boredom that often set in during long, routine missions.

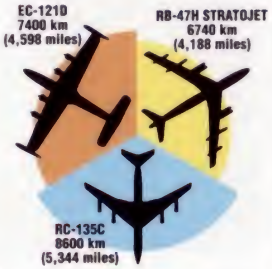
ACTION DATA

MAXIMUM SPEED

When the Warning Stars first entered service, huge radomes were located on the outside of the airframes, restricting the speed of the EC-121s. As technology improved, the equipments could be fitted inside the aircraft, increasing the speed of the jet-powered RC-135.

COMBAT RANGE

The Warning Star retained the range of the Constellation airliner, despite the additional weight of its equipment. Early jet designs had range restricted by the performance of the first-generation jet engines.



OPERATING WEIGHT

To improve the capabilities of the first early warning aircraft, more equipment was continually added to the airframes, which gradually increased their weight. Compared to late-model EC-121s, the early versions of the RC-135s were twice the weight.

Cold War watchers

■ **RB-47H STRATOJET:** Developed from the bomber, the ERB-47H was capable of outrunning most intercepting fighters.

■ **RB-50B SUPERFORTRESS:** One of the first intelligence-gathering aircraft in operation was developed from the B-29.

■ **P4M MERCATOR:** Although limited in numbers, Martin's Mercator saw extensive use around Soviet borders.

LOCKHEED

P-2 NEPTUNE

● Anti-submarine patrol aircraft ● Long service ● Export success

One of the greats of naval aviation, the Lockheed P2V (P-2 from 1962) Neptune was the West's answer to the Soviet Union's awesome submarine threat during the first half of the Cold War. This superb land-based maritime patrol aircraft not only searched for submarines, but also filled an anti-surface vessel role. Neptunes performed various specialized duties for the United States and other nations, and some saw war service as late as 1982.

▲ *A veteran of wars in Southeast Asia and the South Atlantic, the P-2 was built in large numbers. More than 1000 served with US and foreign forces.*

PHOTO FILE

LOCKHEED P-2 NEPTUNE

Neptune and its quarry ▶
The Neptune's anti-submarine weapons included rockets, bombs, mines, depth charges and torpedoes. It was never called upon to sink a submarine during the volatile years of the Cold War.

▼ Later colours
This VP-31 SP-2H wears the grey and white colours carried during the last years of US Navy service.

▲ Turbine engines on the P-2J
Between 1969 and 1979 Kawasaki built 82 Neptunes with General Electric T64 turboprop engines and improved avionics.

▼ Popular P2V-5
Built in larger numbers than any other version, P2V-5 production totalled 372. Most later had a MAD boom and jet boosters fitted.

'Midnight blue' P2V-2 ▶
This 'midnight blue' Neptune is typical of the earliest Neptune variants, before the addition of a raised cockpit, jet engines, tip-tanks and a MAD boom.

FACTS AND FIGURES

- During the 1950–53 Korean War P2Vs dropped secret agents behind enemy lines, even into Manchuria.
- In all, 1181 of these great planes were built; the prototype flew on 17 May 1945.
- Twelve modified P2Vs served briefly as carrier-based atomic bombers.
- In 1982 an Argentine Neptune guided the Super Etendard which sank the destroyer HMS *Sheffield* with an Exocet missile.
- The largest foreign P-2 fleet was Japan's, and included Japanese-built P-2Js.
- In Vietnam the US Army used AP-2Es to relay communications from secret agents.

PROFILE

Patrolling 'king of the sea'

With a crew of between seven and 12 men, depending on the model and mission, the Lockheed P2V Neptune spent most of its career stalking Soviet submarines. It also served in other capacities, including electronic intelligence, drone launching and electronic countermeasures training.

Perhaps the most famous achievement of this maritime patrol ship was a distance record that has stood the test of time. Piloted by Commander Thomas P. Davies, a P2V-1 named *The Truculent Turtle* flew 18,227 km (11,326 miles) from Perth, Australia, to Columbus, Ohio, in 55 hours and 17 minutes. This record demonstrated the Neptune's superb range and endurance.

The Neptune's ease of handling and manoeuvrability, with its unusually large rudder, and its spacious accommodation made it popular with Navy crews. Best remembered are the blue-painted Neptunes that prowled the world's oceans. With its maritime patrol capabilities and potential for other military duties, the Neptune was also widely exported, with customers including Australia, Argentina, Brazil, Britain and Canada.

Above: The Royal Canadian Air Force took delivery of 25 P2V-7s in the mid-1950s. When they were replaced in the early 1970s by the CP-107 Argus, many were converted for civilian fire-fighting.

Below: In 1952 P2V-5s entered service with four squadrons of RAF Coastal Command as the Neptune MR.Mk 1. The majority were later fitted with MAD (magnetic anomaly detector) 'stings' and a Plexiglass nose.

SP-2H Neptune

Type: long-range anti-submarine and maritime patrol aircraft

Powerplant: two 2610-kW (3,500-hp) Wright R-3350-32W Turbo-Compound radial piston engines and two 15.1-kN (3,396-lb-thrust) Westinghouse J34-WE-36 turbojets

Maximum speed: 648 km/h (403 mph) at 4265 m (13,993 ft)

Maximum range: 5930 km (3,685 miles)

Service ceiling: 6800 m (22,310 ft)

Weights: empty 22,650 kg (49,935 lb); maximum take-off 36,240 kg (79,896 lb)

Armament: two 12.7-mm (0.5-in) machine guns in dorsal turret, plus provision for underwing rockets and up to 3628 kg (8,000 lb) of weapons

Dimensions:

span	31.65 m (103 ft 10 in)
length	27.94 m (91 ft 8 in)
height	8.94 m (29 ft 4 in)
wing area	92.90 m² (1,000 sq ft)

SP-2H Neptune

Originally designated P2V-7S, the SP-2H was a conversion of the last Neptune production variant, the P2V-7. Aircraft 140967 carries the 'YB' tailcodes of Patrol Squadron 1 (VP-1) in the early 1960s.

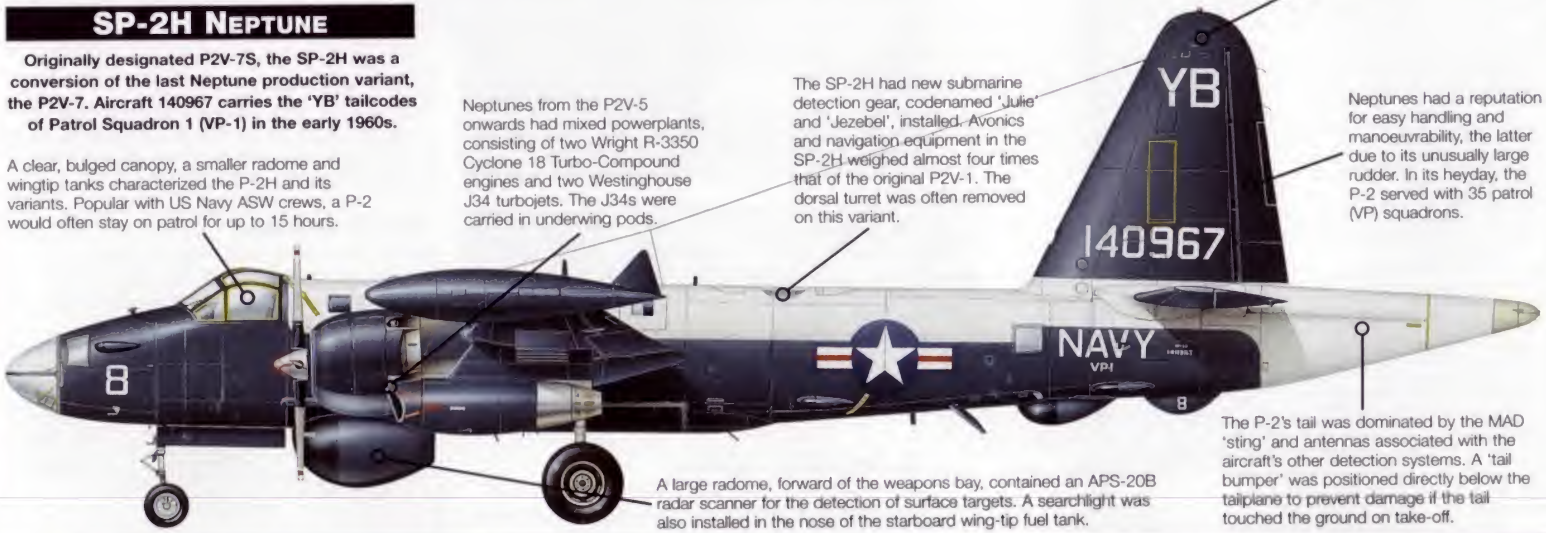
A clear, bulged canopy, a smaller radome and wingtip tanks characterized the P-2H and its variants. Popular with US Navy ASW crews, a P-2 would often stay on patrol for up to 15 hours.

Neptunes from the P2V-5 onwards had mixed powerplants, consisting of two Wright R-3350 Cyclone 18 Turbo-Compound engines and two Westinghouse J34 turbojets. The J34s were carried in underwing pods.

The SP-2H had new submarine detection gear, codenamed 'Julie' and 'Jezebel', installed. Avionics and navigation equipment in the SP-2H weighed almost four times that of the original P2V-1. The dorsal turret was often removed on this variant.

The colour scheme worn by this aircraft was an intermediate livery between the early all-over 'midnight blue' and the white and grey used in later years.

Neptunes had a reputation for easy handling and manoeuvrability, the latter due to its unusually large rudder. In its heyday, the P-2 served with 35 patrol (VP) squadrons.



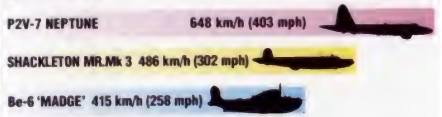
A large radome, forward of the weapons bay, contained an APS-20B radar scanner for the detection of surface targets. A searchlight was also installed in the nose of the starboard wing-tip fuel tank.

The P-2's tail was dominated by the MAD 'sting' and antennas associated with the aircraft's other detection systems. A 'tail bumper' was positioned directly below the tailplane to prevent damage if the tail touched the ground on take-off.

ACTION DATA

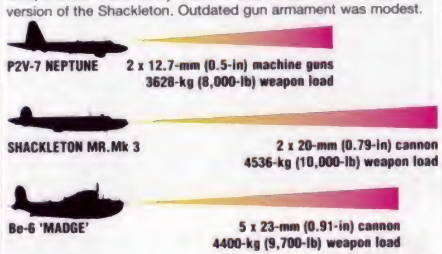
MAXIMUM SPEED

With its Turbo-Compound engines, which used the piston engines' exhausts as a source of extra thrust, and jet boosters, the P2V-7 (P-2H) had a good speed advantage over the RAF Shackleton and Soviet Be-6.



ARMAMENT

Although the later Neptune variants could carry a large weapons load, this was bettered by almost a tonne in the final maritime version of the Shackleton. Outdated gun armament was modest.



RANGE

Both the Neptune and Shackleton were capable of impressive range, which also allowed longer loiter times while on patrol. The Beriev Be-6's range was 1000 km (620 miles) less than that of the Western machines, but it was not reliant upon land bases.

Neptunes in service worldwide

■ **BRITISH STOP-GAP:** This Neptune MR.Mk 1 wears the markings of No. 217 Squadron, one of four Coastal Command units equipped with Neptunes under the Mutual Defense Assistance Program. They were replaced by Avro Shackletons.

■ **OVER THE HO CHI MINH TRAIL :** US Navy unit VAH-21 operated the AP-2H as a 'gunship' from Cam Ranh Bay, South Vietnam. Armed with guns and grenade launchers, these aircraft attacked truck convoys resupplying the Viet Cong.

■ **FALKLANDS VETERANS:** Argentina acquired a number of P2V-5s from Great Britain and later operated SP-2Hs. A number of SP-2Hs were flown on support missions during the Falklands War. Argentina was one of the last P-2 operators.

LOCKHEED

C-130A-E HERCULES

● Versatile airlifter ● Widely exported ● Still going strong

▲ *Not revolutionary when it first appeared, the C-130 was, nevertheless, the first transport aircraft to incorporate all the latest technological features in a single package.*

Designed from 1951 for the US Air Force's Tactical Air Command, the C-130 set a new pattern for military transport aircraft. Previous types usually had piston engines, tailwheel landing gear and side doors. The Hercules used turboprops for improved performance, a high-set wing to avoid encroaching on the cargo space and to provide excellent STOL capability, and a sturdy tricycle landing gear to allow it to operate from unpaved airstrips.

PHOTO FILE

LOCKHEED C-130A-E HERCULES

◀ Hotrod Hercules
A lack of external wing tanks were a distinguishing feature of the C-130B. With uprated engines, this variant was the fastest of all production Hercules. Canada acquired 24 of the type.

Relief flights ▶
Since the mid-1950s, when they first entered service, C-130s have flown thousands of humanitarian missions around the world.

◀ First of the many
Displaying the small nose radome, the original prototype YC13-A (serialled 53-3396) takes off on an early flight. Early production C-130As were virtually identical to the prototypes.

▼ Arctic operations
Among the rarest of all Hercules were the ski-equipped C-130Ds flown by the New York Air National Guard. These aircraft were used to supply radar stations located in the Arctic.

▲ Caught on the ground
Seen after being hit by Viet Cong mortar, a USAF C-130 burns at Dak To. Viet Cong sappers did more damage to C-130s than anti-aircraft fire in 'Nam.

FACTS AND FIGURES

- The first Hercules actually to fly was the second prototype YC-130A, which took to the air on 23 August 1954.
- C-130As were the only variants to be delivered with three-bladed propellers.
- The longer-ranged C-130E was bought by nine countries outside the United States.
- In Vietnam, the Hercules played a vital part in delivering supplies to the besieged US Marine bases at Khe Sahn.
- Many early USAF C130-As were converted into extremely capable gunships.
- All seven of the C-130Bs delivered to South Africa in 1962 remain in service.

PROFIL

Backbone of world's air forces

Produced by Lockheed's Skunk Works, the first prototype Hercules flew in August 1954. Deliveries of the first major production version, the C-130A, began in December 1955, with 231 completed.

Another 18 were converted to AC-130A gunship configuration, with four 20-mm (0.79-in) and four 7.62-mm (0.3-in) guns for close air support in Vietnam and Laos. Later gunship platforms based on the C-130E model had improved armament comprising twin 40-mm (1.57-in) guns in place of the 20-mm ones, and, ultimately, an enormous 105-mm (4.13-in) howitzer.

The C130-B introduced four-bladed propellers as standard and incorporated numerous other improvements. It was bought by the USAF and several other countries. Aircraft in US service were adapted for a variety of different roles such as search and rescue for the Coast Guard, drone control, weather reconnaissance, satellite recovery and intelligence gathering. Other variants included KC-130F tankers for the US Marine Corps.

Approximately 12 C-130A models modified with ski undercarriage were designated C-130D and used for operations in the Arctic, supplying the DEW (Distant Early Warning) radar stations. The next major production variant was the C-130E tailored towards Military Airlift Command operations, as opposed to the previous versions which had been tactical.

This model was bought in larger numbers by overseas countries. Like the C-130B, it spawned numerous sub-variants, including the MC-130E Rivet Clamp aircraft used for special operations. Others included the specialist EC-130Es, which played a key role right up to the time of the First Gulf War.

Left: External fuel tanks located between the engines were an identifying feature of the C-130E.

Above: An outstanding attribute of the C-130 is its ability to carry large loads into small airfields. Here, a Cessna T37 fuselage is manhandled into the enormous cabin.

C-130A Hercules

Type: four-engined military transport aircraft

Powerplant: four 2796-kW (3,749-hp) Allison T56-A9 turboprop engines

Maximum speed: 616 km/h (383 mph)

Cruising speed: 528 km/h (328 mph)

Initial climb rate: 783 m/min (2,569 fpm)

Range: 4110 km (2,554 miles)

Service ceiling: 12,590 m (41,306 ft)

Weights: empty 26,911 kg (59,329 lb); loaded 48,988 kg (108,000 lb)

Dimensions:

span	40.41 m (132 ft 7 in)
length	29.79 m (97 ft 9 in)
height	11.66 m (38 ft 3 in)
wing area	162.12 m² (1,745 sq ft)

C-130B Hercules

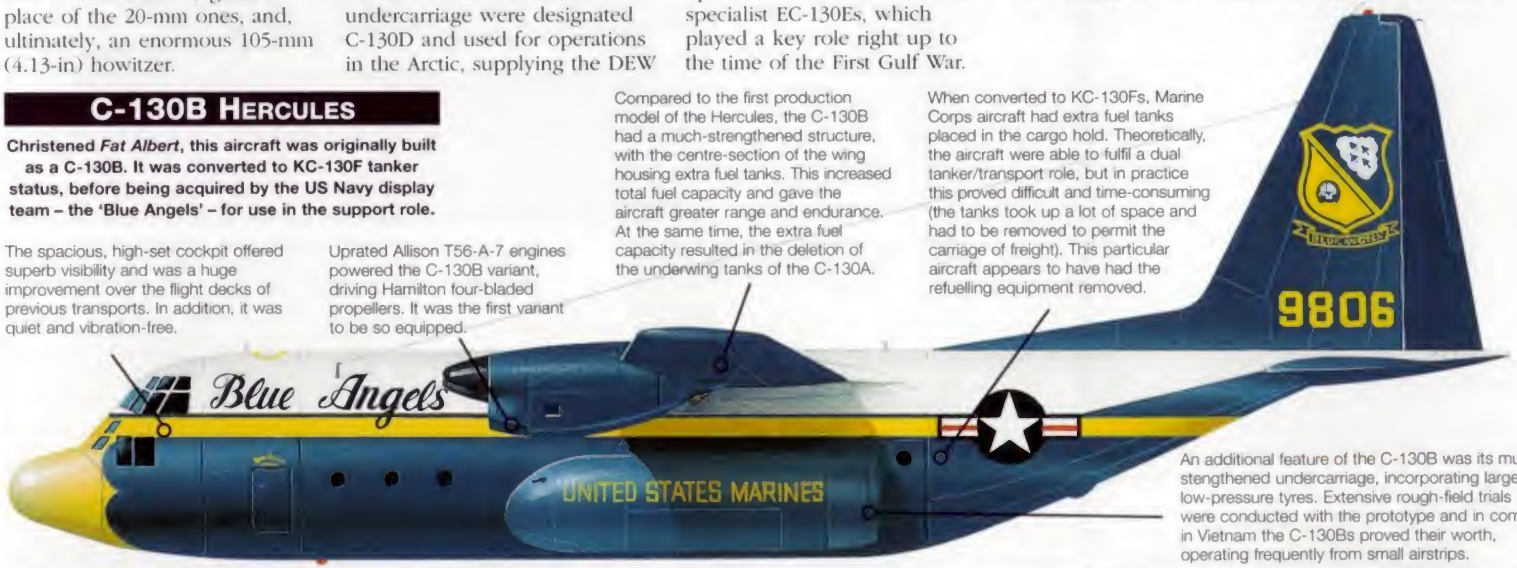
Christened *Fat Albert*, this aircraft was originally built as a C-130B. It was converted to KC-130F tanker status, before being acquired by the US Navy display team – the 'Blue Angels' – for use in the support role.

The spacious, high-set cockpit offered superb visibility and was a huge improvement over the flight decks of previous transports. In addition, it was quiet and vibration-free.

Uprated Allison T56-A-7 engines powered the C-130B variant, driving Hamilton four-bladed propellers. It was the first variant to be so equipped.

Compared to the first production model of the Hercules, the C-130B had a much-strengthened structure, with the centre-section of the wing housing extra fuel tanks. This increased total fuel capacity and gave the aircraft greater range and endurance. At the same time, the extra fuel capacity resulted in the deletion of the underwing tanks of the C-130A.

When converted to KC-130Fs, Marine Corps aircraft had extra fuel tanks placed in the cargo hold. Theoretically, the aircraft were able to fulfil a dual tanker/transport role, but in practice this proved difficult and time-consuming (the tanks took up a lot of space and had to be removed to permit the carriage of freight). This particular aircraft appears to have had the refuelling equipment removed.

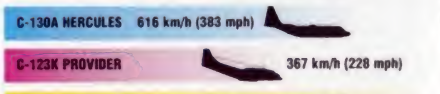


An additional feature of the C-130B was its much-stengthened undercarriage, incorporating larger, low-pressure tyres. Extensive rough-field trials were conducted with the prototype and in combat in Vietnam the C-130Bs proved their worth, operating frequently from small airstrips.

ACTION DATA

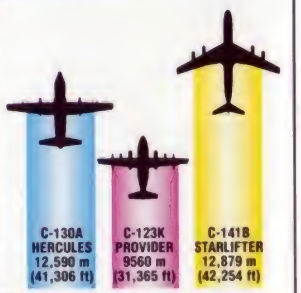
MAXIMUM SPEED

Faster than the older piston-engined Fairchild C-123, the Hercules considerably raised the performance of military transports in the 1950s. The later Lockheed C-141 StarLifter offered jet performance and increased cargo capacity, but was not STOL-capable.



SERVICE CEILING

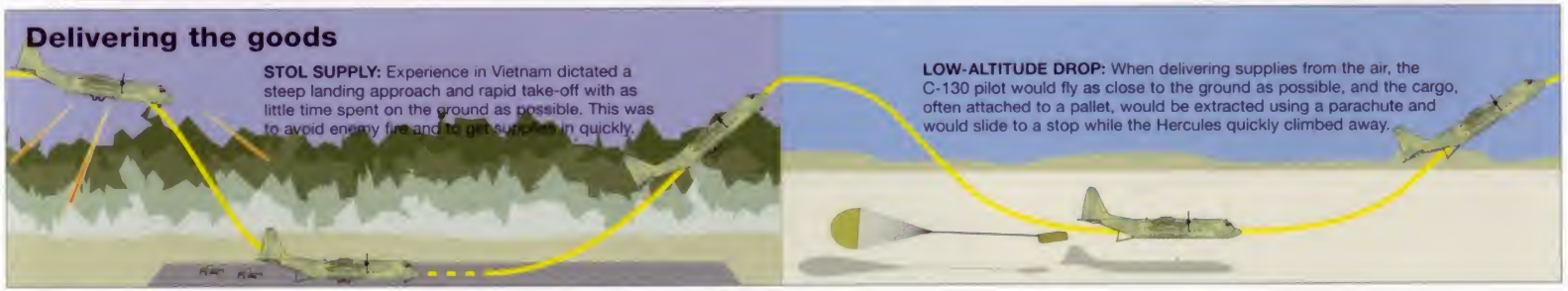
The rapid advance in aviation technology is clearly evident in the different capabilities of these three aircraft, which entered service within 15 years of each other. Although the C-141 StarLifter ushered in a new era of USAF jet-powered transports when it began operations in 1965, the older types were still considered indispensable.



MAXIMUM PAYLOAD

Being able to carry much more, the C-141 should be the natural successor to both other types. It was the first aircraft to give the USAF truly global logistic support capabilities. However, the keys to the continuing success of the Hercules were its rough-field capability and simple design.

Delivering the goods



STOL SUPPLY: Experience in Vietnam dictated a steep landing approach and rapid take-off with as little time spent on the ground as possible. This was to avoid enemy fire and to get supplies in quickly.

LOW-ALTITUDE DROP: When delivering supplies from the air, the C-130 pilot would fly as close to the ground as possible, and the cargo, often attached to a pallet, would be extracted using a parachute and would slide to a stop while the Hercules quickly climbed away.

LOCKHEED

F-104 STARFIGHTER

● Interceptor ● Lightweight fighter ● Record holder

The Lockheed F-104A Starfighter was known as the 'Zipper' to pilots who flew the aircraft during its brief, unsuccessful US military career. But the sleek, futuristic fighter was not a failure. Designed with speed as its primary feature, the F-104A was a fast performer. It extended the boundaries of fighter performance in the 1950s, and brought Mach 2 capability to more than two dozen air forces around the world.

▲ *An F-104A pilot stands next to the powerful 20-mm (0.79-in) Vulcan cannon fitted to the USAF Starfighters and one of its ancestors, the nineteenth-century Gatling gun.*

PHOTO FILE

LOCKHEED F-104 STARFIGHTER

▲ Two-seat trainer
Conversion training was made easier by the introduction of the F-104B tandem-seat trainer.

▼ NASA test
The F-104's high speed made it useful for NASA, both in high-speed test flights and as a chase aircraft.

▲ Record breaker
The USAF set many performance records with its F-104As, especially for speed and altitude. But the operational success of the aircraft was less spectacular.

▲ Single engine
The Starfighter was powered by a single J79 engine, the same one that powered the later F-4 Phantom in twin-engined configuration.

Wingtip ▶ missiles
Originally designed for US Navy aircraft, the early versions of the Sidewinder missile were brought into USAF service with the F-104. They initially proved only marginally more reliable than the Starfighter.

FACTS AND FIGURES

- The first Starfighters were transferred from the US Air Defense Command to the Air National Guard.
- The Lockheed XF-104 Starfighter made its first flight on 4 March 1954.
- At its deepest point the F-104A wing was only 10.16 cm (4 in) thick.
- In history's first encounter between Mach 2 fighters in 1965, a Pakistani F-104A outran pursuing Indian MiG-21s.
- Improved F-104Cs were operated by Tactical Air Command into the mid-1960s.
- The F-104A was the first aircraft to hold simultaneous speed and altitude records.

PROFILE

First of the Starfighters

The Lockheed F-104 Starfighter was just what the public of the 1950s expected a supersonic fighter to look like. Long, sleek and with a rocket-like fuselage and tiny, impossibly sharp-edged wings, the aircraft looked as though it was itching to break the sound barrier even when sitting motionless on the ground.

Designed by the great 'Kelly' Johnson to be as small as possible, the F-104's wings were optimized for Mach 2 performance. At subsonic speeds where most combat takes place, however, the F-104 was at a disadvantage. Its small size meant that there was very little room for extra equipment, and it fell out of favour with the US Air Force. Still, its speed made it popular with air forces around the world.

The F-104 saw relatively little combat. USAF fighters flew uneventful patrols in Vietnam, while Pakistan's F-104As were involved in actions against India, and Taiwanese aircraft tussled with Chinese MiGs. But to most who flew it the F-104 was simply the incredibly fast fighter that was never needed in the Cold War.

Right: Designers went to great lengths to turn out very fast missile-armed interceptors in the mid-1950s. Pilots then discovered that agile, slower aircraft with reliable cannon were often more effective in real battles.

Left: The USAF never really liked the concept of light fighters, preferring heavy, fast, expensive all-weather types such as the F-4 Phantom. The F-104 had more success in the new role as a tactical nuclear bomber in Europe.

F-104A Starfighter

Type: single-seat supersonic fighter

Powerplant: one 65.83-kN (14,806-lb-thrust) afterburning General Electric J79-GE-11A turbojet

Maximum speed: 2100 km/h (1,305 mph) at 12,190 m (40,000 ft)

Combat radius: 800 km (497 miles)

Service ceiling: 16,764 m (55,000 ft)

Weights: 9880 kg (21,782 lb) loaded

Armament: one 20-mm (0.79-in) General Electric M61A1 Vulcan six-barrel rotary cannon with 725 rounds; two AIM-9 Sidewinder missiles and up to 1814 kg (4,000 lb) of bombs

Dimensions:

span	6.68 m (21 ft 11 in)
length	16.69 m (54 ft 9 in)
height	4.11 m (13 ft 6 in)
wing area	18.22 m² (196 sq ft)

F-104C Starfighter

The 479th TFW operated the F-104C from Da Nang in 1965 to provide cover for tactical operations. The Starfighter did not see extensive service in Vietnam, being too short on range to be a useful escort fighter.

Original F-104s had a downward-firing ejector seat, a feature more usually found in Soviet jets. The reason for this was that designers feared an upward-firing seat might hit the tailplane, which turned out not to be the case.

Visibility from the F-104 was surprisingly good for a fighter of the time. The area in front of the canopy was painted black to reduce glare for the pilot.

USAF F-104s were originally left in bare metal finish. Deployment to Southeast Asia, however, led to the adoption of a three-tone tactical camouflage.

The T-tail configuration was used to retain pitch control authority at transonic speed. This had been a problem in earlier designs flying close to the sound barrier.

The Starfighter was not originally designed to have radar, a decision that was soon changed. A simple range-only set was fitted, and later versions built abroad had greatly improved radars.

Designers of the F-104 regarded the missile as its main armament, but did not dispense with the gun, retaining a Vulcan 20-mm (0.79-in) rotary cannon.

The F-104C Starfighter was powered by an afterburning J79-GE-7. Later versions of the F-104 used even more powerful variants of this engine which went on to power the F-4.

The tiny 6-m (19-ft 8-in) wing was optimized for Mach 2 performance. It had large anhedral, or downward angle, which gave a very high rate of roll. The wing's leading edge had to be covered with a guard when the aircraft was on the ground to prevent injuries to the ground crews.

COMBAT DATA

MAXIMUM SPEED

The F-104, like the Lightning, had staggering speed and climb rate gained at the expense of versatility, range and weapon load.

AGILITY

Short wings with high wing loading meant that both the F-104 and the Lightning could be out-turned by the more agile MiG-21 with its delta wing.

Early century series fighters

■ **F-100 SUPER SABRE:** The F-100 was the first American fighter to exceed Mach 1 in level flight. It saw extensive service in the Vietnam War as a tactical fighter-bomber.

■ **F-101 VOODOO:** Big, heavy and very complicated, the Voodoo was the antithesis of the F-104. It was a potent aircraft, with advanced fire-control and nuclear rocket armament.

■ **F-102 DELTA DAGGER:** Another heavy and costly fighter, the F-102 was a problematic design at first, but like the F-104 it eventually matured into a more successful aircraft.

LOCKHEED

U-2

● Spy aircraft ● 'Skunk Works' design ● Gary Powers shoot-down

▲ *The U-2 program was kept a secret from the public for many years, but after the Gary Powers incident the veil was lifted – a little. This U-2 at an airshow has missile-tracking cameras on the spine.*

Operated by the Air Force and the Central Intelligence Agency, the U-2 was designed at the height of the Cold War to penetrate heavily defended airspace and bring back photos and data on the enemy's most secret installations. The aircraft was built and flew its missions in great secrecy. When one was shot down over Russia, the U-2 became a household name. The type was used over Iraq in the 1990s and remains in service with NASA.

PHOTO FILE

LOCKHEED U-2

▲ Safety problems
Until a U-2A was rebuilt as a two-seat U-2CT conversion trainer in 1973, accidents were not infrequent. This aircraft crashed in Germany in 1975.

▲ First production model
About 40 of the U-2A model were built, along with seven U-2Bs, which had a more powerful engine and greater fuel capacity.

Blacked out ▶
Not to be confused with the later U-2R and TR-1 variants, this all-black U-2D was one of only five of this model to be made.

Cuban crisis ▶
U-2s were involved in the Cuban Missile Crisis in 1962 and flew over Cuba looking for Russian nuclear missiles. This U-2D was based in Florida in the early 1960s.

▲ Spies in the sky
Most of the earliest U-2s were operated by the CIA before being passed to the Air Force.

U-2 in the U.K. ▶
This U-2C was used in trials of a radar-locating system from UK bases in the mid 1970s.

FACTS AND FIGURES

- U-2Gs undertook trials to see if the type could operate from aircraft carriers.
- The only other country to use U-2s was Taiwan, a number of which were lost over mainland China.
- The U-2's wing worked well at high altitude, but made landings tricky.
- The U-2 was put back into production twice, and improved U-2R models have seen service over Bosnia and Iraq.
- NASA uses a version of the U-2 called the ER-2 for earth resources mapping.
- The U-2 pilot used an external mirror to check if he was leaving a contrail.

PROFILE

Cold War spies

The traditional matt-black finish became synonymous with the U-2. Few markings or national insignia were carried, other than a serial number, though this was often bogus.

The Experimental Department of Lockheed Aircraft Corporation was known as the 'Skunk Works'. The first, and arguably the most famous, of their secret projects was the U-2. Designed in record time under the direction of the Works' director, Clarence 'Kelly' Johnson, it met a joint Central Intelligence Agency (CIA)/USAF requirement for an espionage reconnaissance aircraft.

Work began in 1954, on what was essentially a powered glider. The 'Dragon Lady', as it became known, first flew in 1955 and entered service in the late 1950s, crewed by CIA personnel. The U, for Utility, designation was used by the Department of Defense to hide the true role of the aircraft. Flights over the Soviet Union were made until 1 May 1960, when one was shot down over Sverdlovsk. From then on flights were restricted to spy sorties over non-Soviet territory and secondary tasks like high-altitude sampling, the USAF eventually taking over their operation.

Up to 1960 around 54 had been built in all. In 1967, a second-generation aircraft, the U-2R, flew for the first time and remains in service today.

U-2C

56-6700 was built in the late 1950s as a U-2A. Converted to a U-2C, it was involved in the Pave Onyx Advanced Location and Strike System trials in 1975, with ALSS orbiting aircraft precisely located hostile radar sites.

Two 'slipper' fuel tanks with a capacity of 477 litres (105 gallons) each were fitted to U-2Bs and Cs to improve range performance. Total fuel capacity was 6956 litres (1530 gallons). Range was over 7275 km (4520 miles).

A rearward-facing radar warning receiver (RWR) was fitted inside a fairing on the trailing edge of the starboard wing. This warns the pilot of the presence of hostile radar associated with a surface-to-air missile site or fighter aircraft.

This camouflage scheme was worn by aircraft used on the 1975 ALSS trials flown from RAF Wethersfield, codenamed 'Constant Treat'.

The key to the U-2's altitude and range performance was its long-span wings. It was effectively a powered glider, with its high aspect ratio wing and lightweight structure.

To save weight the first U-2s were not fitted with an ejection seat, though they were added later. The type has a reputation for being difficult to handle on landing.

The Q-bay behind the pilot housed the principal sensors and/or cameras. A smaller bay was built into the nose of the aircraft.

Communications, navigation and mission equipment was housed in the long dorsal spine of the U-2C. U-2Fs were similar but had a refueling receptacle at the front.

The U-2A used a Pratt & Whitney J57 turbojet, however all subsequent variants were fitted with a larger J75, of the type fitted, with an afterburner, to the F-105 Thunderchief.

For the Pave Onyx program, the Q-bay had a bulged dielectric lower hatch for the 18 ALSS electronic intelligence antennas.

Jettisonable wheels, known as 'pogos', were mounted under the wings to support them during taxi and take-off.

To shield the exhaust from infrared sensors or missile seeker heads, a 'sugar scoop' was fitted to the lower portion of the jetpipe.

U-2B

Type: single-seat high-altitude reconnaissance aircraft

Powerplant: one non-afterburning 75.65-kN (17,000-lb-thrust) J75-P-13B turbojet

Maximum speed: more than 853 km/h (530 mph) at 42,000 ft)

Initial climb rate: 1524 m/min (5000 fpm)

Range: more than 6840 km (4520 miles)

Service ceiling: 24,080 m (79,000 ft)

Weapons: none

Weights: empty 5888 kg (12,980 lb); loaded 10,478 kg (23,100 lb)

Dimensions:

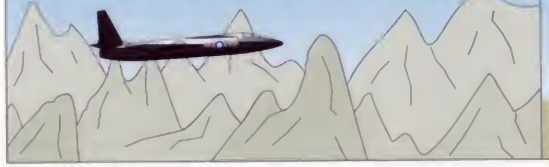
span	24.38 m (80 ft)
length	15.14 m (49 ft 8 in)
height	4.62 m (15 ft 2 in)
wing area	447.42 m² (600 sq ft)

INTERCEPTED: The Soviets were aware of the spy flights and did all they could to destroy a U-2. They were lucky to hit Powers's aircraft with an SA-2. Much propaganda was made of Powers's capture and arms talks were disrupted. He was tried as a spy, and later returned to the United States in a swap with a Russian agent.

SPY FLIGHT PLAN: Gary Powers's U-2 took off from Peshawar, Pakistan, to fly over the Soviet missile test base at Sverdlovsk. His route avoided known SA-2 missile sites and the plan was to carry on to Bodø in Norway rather than return over a predictable flight path.

The U-2 incident

SECRET MISSION: On 1 May 1960, CIA U-2 pilot Francis Gary Powers took off from a secret base in Pakistan to fly over and photograph several strategic bases in the Soviet Union. He would fly at 22,860 m (75,000 ft), out of the range of surface-to-air missiles.



TARGET SVERDLOVSK: For the photo run, Powers had to concentrate on flying straight and level over the target. MiG-15 fighters climbed to intercept the U-2, but could not reach its height.

SHOT DOWN: Possibly because of a technical problem, the U-2 came within range of SA-2 missiles and was hit. Powers ejected and was captured. A missile also destroyed a MiG-15.

LOCKHEED

P-3 ORION

● Maritime patrol ● Anti-submarine warfare ● Electronic listener

▲ *The four-turboprop Lockheed Orion maritime patrol aircraft has remained virtually unchanged in appearance from the initial P-3 to the US Navy's latest P-3C Update IV.*

Adapting airliner designs to the maritime reconnaissance role has long been an inexpensive solution adopted by nations requiring an airborne sea-search capability. The Lockheed Orion, based on the civil Electra, offered four-engined reliability and the necessary range and 'loiter' time for hours of patrol duty. Capable of considerable modification and updating, the Orion has served the US Navy and other air arms for over four decades.

PHOTO FILE

LOCKHEED P-3 ORION

▲ Overseas equipment
P-3s have been supplied to 13 air arms around the world, including Australia, Canada, the Netherlands (P-3C-II above) and Spain, in addition to the US Navy.

▲ Anti-submarine
When a submarine or ship is identified on the surface, it is visually identified and photographed using the fixed KA-74 camera and hand-held equipment.

▲ Updates
Older P-3s are being updated to incorporate the latest equipment. Australian P-3s, for example, are having new data processors and weapons fitted.

▲ Attack
Various offensive weapons can be carried on underwing pylons, including mines, rocket projectiles or Harpoon medium-range anti-ship missiles. In addition, the P-3 can carry torpedoes, mines and depth bombs internally.

◀ Maritime patrol
The Lockheed P-3 Orion's primary task is to detect, identify and track submarines. For this role it is equipped with a variety of sensors, including a sting-tail mounted MAD and electronics equipment.

FACTS AND FIGURES

- The first flight of the P-3 derivative of the Lockheed Electra airliner took place on 19 August 1958.
- P-3Cs delivered to Norway and South Korea are named Update IIIs.
- Orions have been in production for nearly 40 years, the most recent going to Korea.
- To keep its crew alert on long missions, the P-3 has two rest bunks and a dinette to serve food around the clock.
- EP-3 is an electronic intelligence-gathering (ELINT) version of the P-3C.
- US Coast Guard Orions are used for anti-smuggling patrols.

PROFILE

Lockheed's sub-hunter

One of the most enduring maritime reconnaissance aircraft in service today, the Lockheed P-3 Orion is a powerful submarine hunter. Equipped with an array of advanced sonics equipment including DIFAR (Directional Acoustics-Frequency Analysis and Recording) sonobuoy processing gear and APS-115 search radar, the P-3 can find a periscope in a choppy sea or listen to the noise of a propeller in deep water. The first P-3 flew in the summer of 1962. The upgraded P-3B with better engines but similar mission avionics flew in 1965. The P-3C which first flew in 1968, and remains in service today, has achieved great export success with countries as far apart as New Zealand and Norway.

To undertake its new military role, the P-3 inherited good shortfield performance and handling, as well as ample fuselage space from its civil forebear. A flight crew of four flies the Orion, while a team of six operates the sonics, electronic surveillance and radar equipment in the centre fuselage section. Update programmes have kept the P-3 abreast of advances in military technology, and a new version was offered to the RAF to replace its current Nimrod patrol aircraft.

The US Navy received large numbers of all three main production models: the P-3A/B from 1961 and P-3C from 1968. The latter version remains in service to this day, also equipping the forces of Australia, Canada, Japan, Norway, the Netherlands and Pakistan.

P-3C Orion

Type: long-range anti-submarine patrol and early-warning aircraft

Powerplant: four 3661-kW (4,910-hp) Allison T56-14 turboprop engines

Maximum speed: 761 km/h (473 mph)

Mission radius: 2494 km (1,550 miles)

Service ceiling: 8625 m (28,297 ft)

Weights: empty 27,890 kg (61,487 lb); loaded 64,410 kg (142,000 lb)

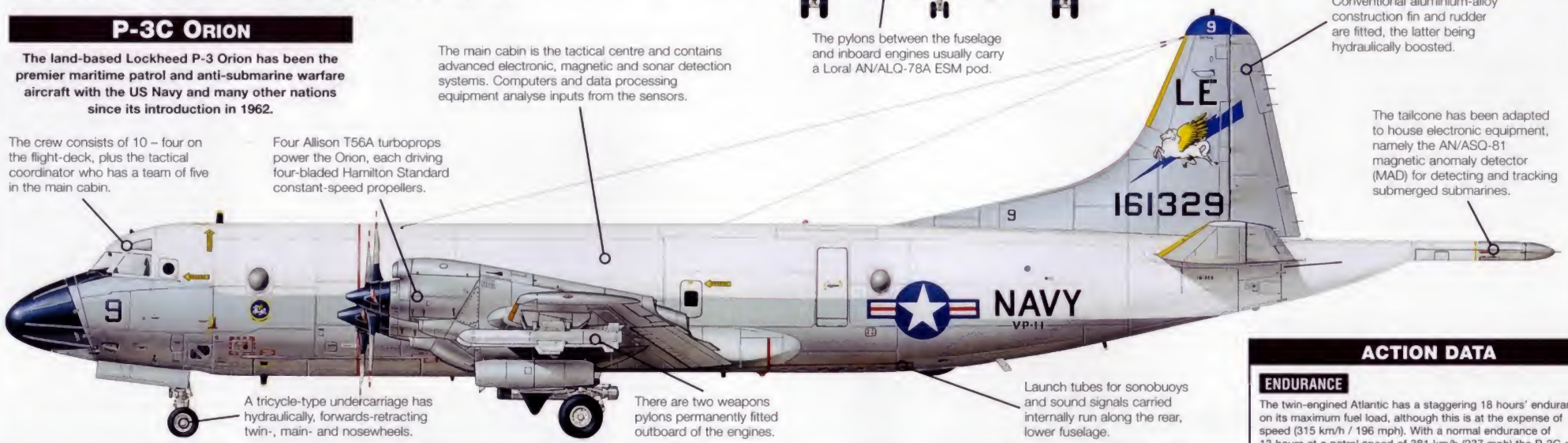
Armament: up to 9076 kg (20,009 lb) of torpedoes, mines, nuclear depth bombs in internal weapons bay, plus depth bombs, torpedoes, Harpoon anti-ship missiles on 10 pylons

Dimensions:

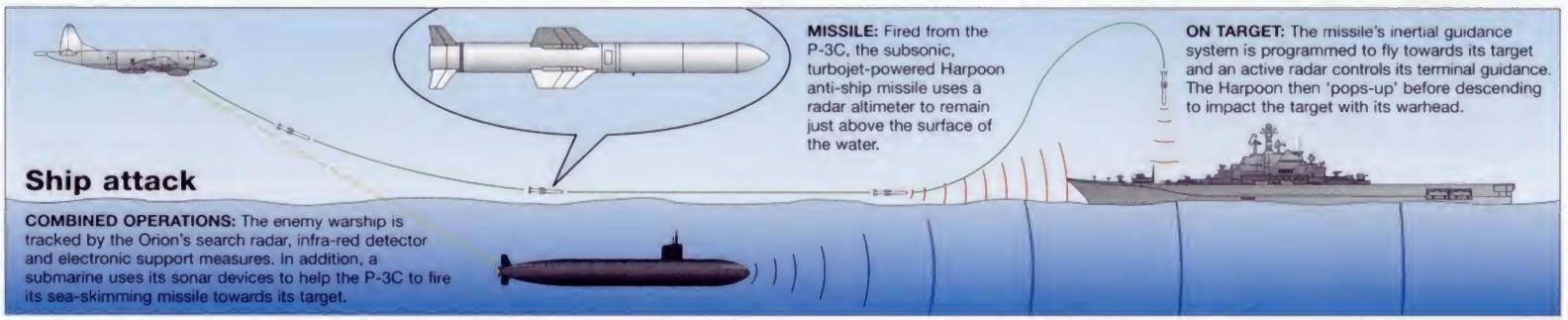
span	30.37 m (99 ft 8 in)
length	35.61 m (116 ft 10 in)
height	10.27 m (33 ft 8 in)
wing area	120.77 m² (1,300 sq ft)

P-3C Orion

The land-based Lockheed P-3 Orion has been the premier maritime patrol and anti-submarine warfare aircraft with the US Navy and many other nations since its introduction in 1962.



Ship attack

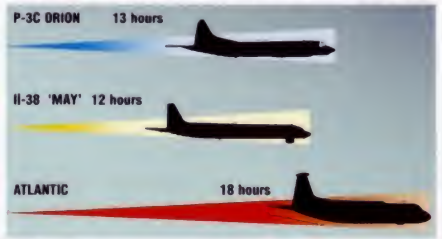


COMBINED OPERATIONS: The enemy warship is tracked by the Orion's search radar, infra-red detector and electronic support measures. In addition, a submarine uses its sonar devices to help the P-3C to fire its sea-skimming missile towards its target.

ACTION DATA

ENDURANCE

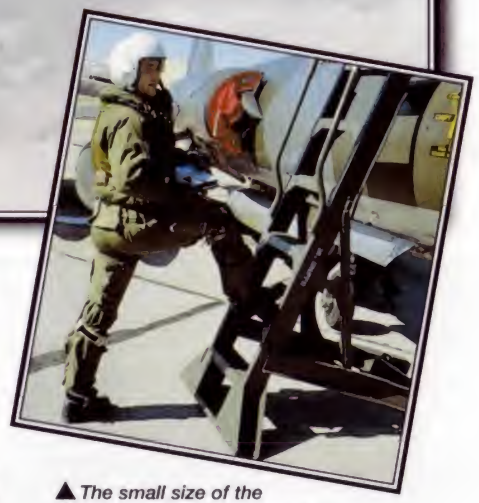
The twin-engined Atlantic has a staggering 18 hours' endurance on its maximum fuel load, although this is at the expense of speed (315 km/h / 196 mph). With a normal endurance of 13 hours at a patrol speed of 381 km/h (237 mph) the P-3C can increase this to over 17 hours by flying on two engines. The Russian Ilyushin Il-38 derivative of the Il-18 airliner has an endurance of 12 hours at a patrol speed of 400 km/h (249 mph).



LOCKHEED

F-104G/S STARFIGHTER

● Lightweight supersonic fighter ● Eight-nation building programme

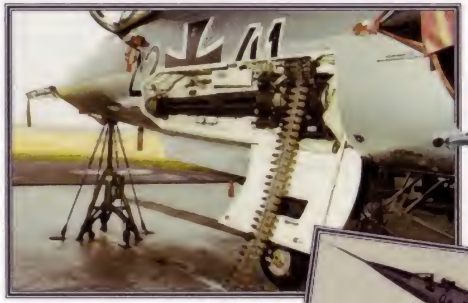


▲ *The small size of the Starfighter belies its stunning performance and considerable combat capability.*

Sharp, sleek and as fast as a flying bullet, the striking Lockheed F-104 Starfighter promised to be the ultimate interceptor. Small, light in weight and with stunning straight-line performance, the F-104 was never agile enough to become what its designers wanted. But it did evolve into a sophisticated all-weather ground-attack aircraft, which inspired mixed reactions in the men who flew it. They either loved the Starfighter, or loathed it.

PHOTO FILE

LOCKHEED F-104G/S STARFIGHTER



▲ Super gun
A brand-new gun was designed for the Starfighter and its contemporaries. The multi-barrel Vulcan cannon could fire an astonishing 6000 20-mm (0.79-in) rounds per minute.

▶ High flyer
Early F-104s were easily the hottest aircraft around. In 1958, the F-104 set new world speed and altitude records.

◀ Rocket launch
A German F-104 was fitted with a powerful rocket to blast it from a 'Zell', or zero-length launcher, straight into the air to flying speed.

◀ Italian stallion
Licence-built in Italy, the F-104S was a dedicated interceptor carrying Sparrow and Sidewinder missiles.

Ship-killer ▶
The German Kriegsmarine flew the F-104G armed with the deadly Kormoran supersonic anti-ship missile.

▲ Mach 2
The Starfighter's tiny wing was not efficient at low speeds, but it was more effective than a swept wing at twice the speed of sound.

FACTS AND FIGURES

- In 1958 Germany purchased the F-104G, sparking many NATO orders in what became known as 'the sale of the century'.
- The Luftwaffe lost 69 Starfighters in the warplane's first four years of service.
- The RF-104G was a dedicated photo-reconnaissance platform.
- In all, 2439 F-104s were built in eight countries between 1954 and 1979.
- The NF-104 was a rocket-powered variant that could zoom to 40,000 m (131,236 ft).
- Italy spent more than $530 million upgrading its Starfighters to F-104ASA standard from 1986 to late 1991.

PROFILE

Missile with a man in it

When it first flew just nine years after the end of World War II, the futuristic look of the Lockheed F-104 Starfighter was simply unbelievable. And its performance matched its rocket-like appearance: even today, so many years later, few aircraft can match the F104's speed and climb rate.

It takes more than that, however, to make a successful fighter. The Starfighter lacked agility, and required sure hands on the controls. As a result the jet had a brief and somewhat accident-prone career with the US Air Force. Instead, Starfighters were to make their mark in a very different role. The much-improved F-104G equipped the ground-attack squadrons of the rapidly growing Luftwaffe and seven other NATO air forces. Nearly 1500 aircraft were built multinationally, giving a much-needed boost to Europe's aviation industry.

Never the easiest aircraft to fly, in German service the F-104 developed an unjustified reputation as a 'widow-maker'. The truth was that accident rates were high for all aircraft of the period, and the Starfighter was actually safer than most of its contemporaries.

The Italian air force operated its upgraded Starfighters until 2004, until they were replaced by the Eurofighter Typhoon.

The F-104's final incarnation is as a very capable ground-attack fighter, built until 1979 by Fiat in Turin and operated by the Italian and Turkish air forces.

F-104G Starfighter

Type: single-seat multi-role fighter and fighter-bomber

Powerplant: one 70.29-kN (15,809-lb-thrust) General Electric J79-GE-11 turbojet with afterburning

Maximum speed: 2092 km/h (1,300 mph) at 12,200 m (40,026 ft)

Initial climb rate: 12,500 m/min (41,010 fpm)

Combat radius: 1200 km (746 miles)

Service ceiling: 16,750 m (54,054 ft)

Weights: empty 6388 kg (14,083 lb); maximum take-off 13,054 kg (28,779 lb)

Armament: one six-barrel M61 Vulcan 20-mm (0.79-in) cannon, two wing-tip AIM-9 Sidewinder heat-seeking air-to-air missiles, up to 1815 kg (4,000 lb) of ordnance on seven underwing and fuselage hardpoints

Dimensions:

span	6.68 m (21 ft 11 in)
length	16.69 m (54 ft 9 in)
height	4.11 m (13 ft 6 in)
wing area	18.22 m² (196 sq ft)

F-104G Starfighter

The German Navy operated this F-104G in the anti-shipping role until early 1982. Based at Schleswig in northern Germany, it is seen carrying two Kormoran anti-ship missiles under the wings.

F-104Gs were retro-fitted with the highly effective British Martin-Baker ejector seat.

The tiny wing that gave the Starfighter its supersonic performance was also its biggest drawback. It was too thin to be used as a fuel tank, and too small to provide much manoeuvrability.

To enable ejecting crew to avoid the Starfighter's high-set tailplane, its designers initially made the disastrous decision to fit a downward-firing ejector seat!

The F-104G (for Germany) was considerably more capable than early USAF versions. It was equipped with a NASARR multimode radar, enabling it to follow the terrain and fly high-speed, all-weather, low-level attacks.

Visibility from the Starfighter's cockpit was not great, but it was not needed in the interceptor role for which the aircraft was designed or for the ground-attack role to which it was converted.

The half-cones in the centre of each of the F-104's engine intakes are designed to improve the flow of air to the Starfighter's powerful General Electric J79-GE-11A engines.

Short range was a problem with the first Mach 2 jets. The F-104 quickly lost its wing-tip missiles to make room for extra streamlined fuel tanks, which greatly increased its endurance.

F-104 OPERATORS IN THE 1970s

The F-104 was the first 'Eurofighter', arming eight continental NATO air forces as well as those of Canada and the USA.

COMBAT DATA

MAXIMUM SPEED

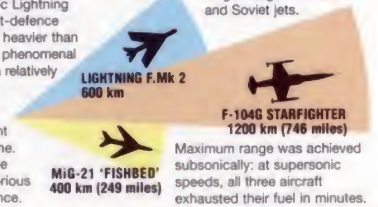
The F-104 was one of the first Mach 2 fighters. It was slower than either the lightweight Soviet MiG or the much more powerful British Lightning.

COMBAT RADIUS

The English Electric Lightning was a classic point-defence fighter. Larger and heavier than the F-104, it had a phenomenal rate of climb, but a relatively short range.

The MiG-21 was also used as a light supersonic machine. More agile than the F-104, it was notorious for its low endurance.

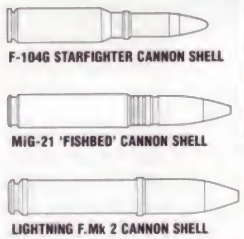
Despite its small size, the F-104 had a considerably longer range than British and Soviet jets.



Maximum range was achieved subsonically: at supersonic speeds, all three aircraft exhausted their fuel in minutes.

CANNONS

On the face of it, the F-104's single 20-mm gun armament cannon was less powerful than its contemporaries. But the six rotating barrels of the M61 Vulcan cannon made up for that by firing its explosive rounds at a rate of 6000 per minute, two or three times the rate of fire of the two 30-mm ADEN guns carried by the Lightning or the 23-mm twin-barrel GSh-23 used to arm the MiG-21. However, the ADEN 30-mm cannon is more likely to give a single-shot kill.



LOCKHEED

SR-71 BLACKBIRD

● High-flying reconnaissance ● World's fastest jet

Lockheed's SR-71 Blackbird was the most spectacular performer ever to leave the ground under its own power and spread wings. Thirty years after entering service the Blackbird was briefly returned to service, but this superlative aircraft has now been permanently retired.

▲ *SR-71s operated at the extreme edge of the Earth's atmosphere, and their crews needed to wear space suits to have a chance of survival in the event of an emergency.*

PHOTO FILE

LOCKHEED SR-71 BLACKBIRD

◀ Stealth pioneer
The SR-71's shape is one of the first examples of the use of stealth technology to reduce the radar cross-section of a combat aircraft.

Hypersonic fighter ▲
The original CIA spyplane was developed into an armed interceptor. The YF-12 was equipped with radar and missiles which were carried in an internal bay.

▲ 'Skunk Works'
This unique reconnaissance ship came from Lockheed's top-secret 'Skunk Works', where the U-2 was also developed and where high-performance aircraft are a tradition.

▲ Spy in the sky
In the SR-71's heyday, a pilot could set off from one of its three main bases and get a photograph of anywhere in the world within six hours.

Unique power and fuel ▶
The SR-71's engines were unique, running on JP7 low-volatility fuel. A fleet of KC-135Q tankers was required to keep the Blackbird in the air.

FACTS AND FIGURES

- The Blackbird crossed the USA at a record speed of 3419 km/h (2,124 mph) in 1990.
- The pressure suits worn by the crew were identical to those used by astronauts on the first four Space Shuttle missions.
- Blackbird missions over North Vietnam were the fastest ever flown in combat.
- One version of this spyplane carried the D-21 drone, launched in flight at supersonic speeds.
- At speed and altitude, friction caused the metal skin of the SR-71 to heat up to 200°C (392°F).

PROFILE

Eye in the sky

When it was first flown in the 1960s, the black, needle-nosed SR-71 was an amazing performer. Today, several decades later, the Blackbird's capability has still never been matched, and the superfast jet was pulled out of early retirement in the 1990s to resume reconnaissance flights.

One pilot who watched this incredible speedster return to flying condition called it a 'magic machine'. Yet the Blackbird was more than a spectacular flier. Using cameras and electronic sensors, the SR-71 was able to look down from above or peer sideways hundreds of kilometres into enemy territory with a clarity that no other reconnaissance aircraft could equal. Before the Cold War ended, the SR-71 flew in support of the NATO Allies, usually staying on its side of the border, but still able to spy on the other side.

The SR-71 had very powerful engines and used special fuel, requiring its own tankers for long missions.

Above: It took a lot of effort to keep the SR-71 and its space-suited pilots in the air. One estimate has put the cost of flying the Blackbird at more than $200,000 per hour.

Below: For many years the US Air Force would say only that the Blackbird cruised 'above 80,000 feet' (24,384 m). It is now known that the jet could reach at least 30,000 m (98,524 ft) without any difficulty, and could probably zoom even higher.

SR-71A Blackbird

Type: two-seat all-weather strategic reconnaissance aircraft with electronic, optical, infra-red or radar sensors

Powerplant: two Pratt & Whitney J58 turbo-ramjets each delivering 144.57-kN (32,516-lb-thrust) static with afterburners

Maximum speed: estimated at Mach 3.5 or more than 4000 km/h (2,485 mph); normal operating speed over Mach 3 or 3700 km/h (2,300 mph)

Range: more than 4000 km (2,485 miles) without refuelling; intercontinental with aerial refuelling

Operational ceiling: 25,900 m (84,974 ft); maximum ceiling estimated to be 30,960 m (101,575 ft)

Weights: empty 27,215 kg (60,000 lb); loaded 76,340 kg (168,300 lb)

Dimensions:

span	16.94 m (55 ft 7 in)
length	32.74 m (197 ft 5 in)
height	5.64 m (18 ft 6 in)
wing area	167.30 m² (1,801 sq ft)

SR-71A BLACKBIRD

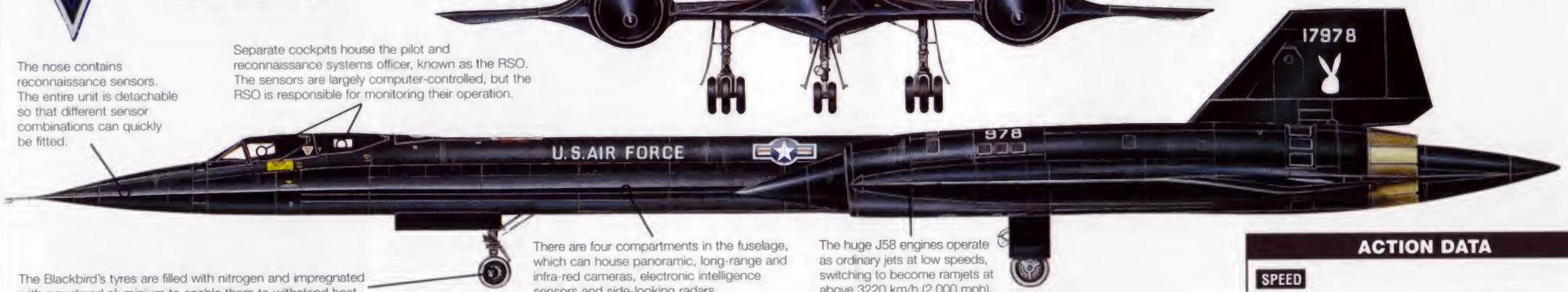
SR-71s were operated by the 9th Strategic Reconnaissance Wing, United States Air Force, Beale AFB, California, with detachments to Kadena on Okinawa and RAF Mildenhall in England.

The black paint is highly sophisticated, specially formulated to radiate excess heat while at the same time disrupting incoming radar energy. At operating temperatures and altitudes, it changes colour to blue.

To withstand the intense friction-generated heat at Mach 3, 93 per cent of the Blackbird's airframe is made of titanium.

The vertical tails are the only large, flat surfaces on the Blackbird. They are canted slightly inboard, in an attempt to deflect the large radar returns they would produce.

The component parts of the Blackbird fit very loosely, to allow for expansion at high temperatures. At rest on the ground fuel leaks out constantly, as the six large tanks in the fuselage and wings only seal at operating temperatures. There is little danger, however, as the fuel is very stable with an extremely high flash point.



The nose contains reconnaissance sensors. The entire unit is detachable so that different sensor combinations can quickly be fitted.

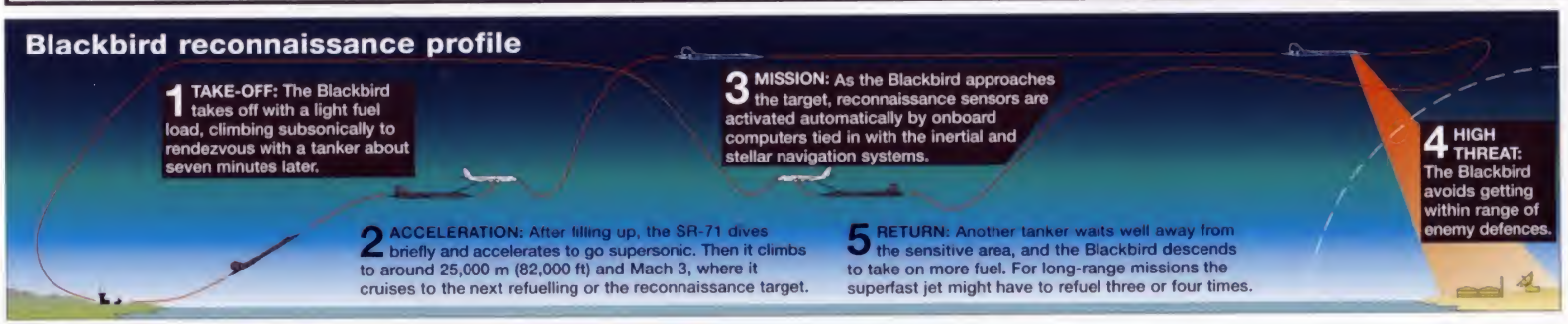
Separate cockpits house the pilot and reconnaissance systems officer, known as the RSO. The sensors are largely computer-controlled, but the RSO is responsible for monitoring their operation.

The Blackbird's tyres are filled with nitrogen and impregnated with powdered aluminium to enable them to withstand heat.

There are four compartments in the fuselage, which can house panoramic, long-range and infra-red cameras, electronic intelligence sensors and side-looking radars.

The huge J58 engines operate as ordinary jets at low speeds, switching to become ramjets at above 3220 km/h (2,000 mph).

Blackbird reconnaissance profile



ACTION DATA

SPEED

The only aircraft which even approaches the Blackbird's speed is the MiG-25, and it can only sustain Mach 3 for a few minutes, compared to the eight-hour supersonic missions regularly flown by the SR-71. The Anglo-French Concorde is the only other aircraft which could sustain supersonic flight for hours at a time.

SR-71 BLACKBIRD
Operational speed — over 3600 km/h (2,237 mph)

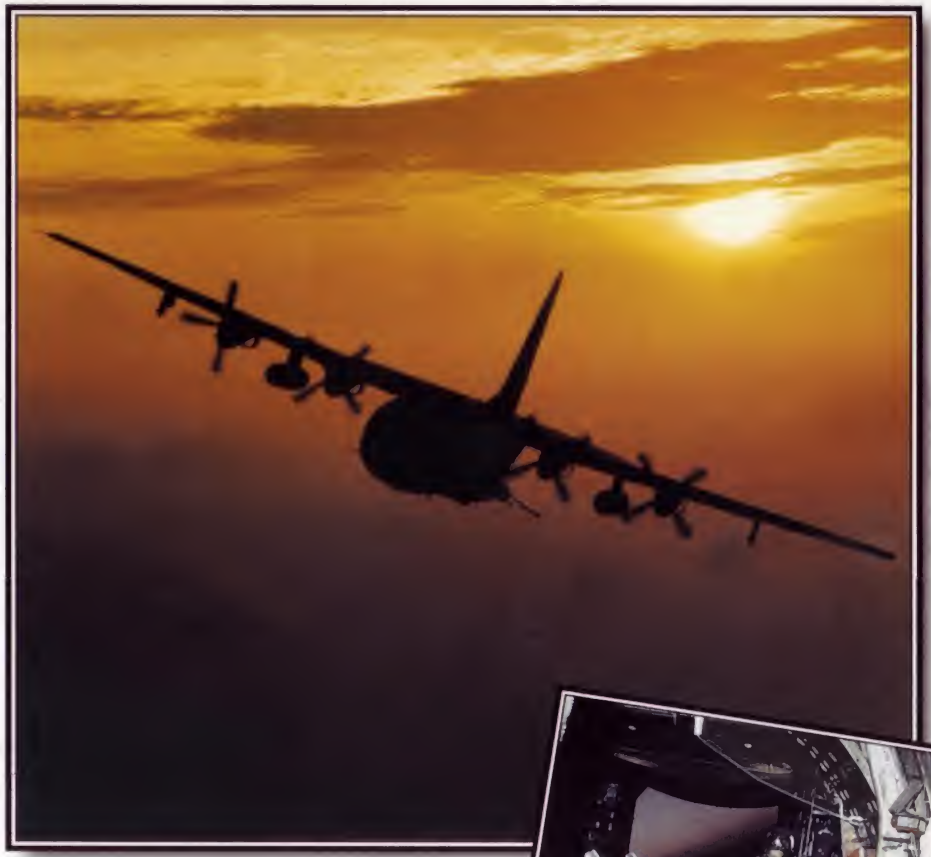
MiG-25R 'FOXBAT-B'
Maximum speed — 3000 km/h (1,864 mph)

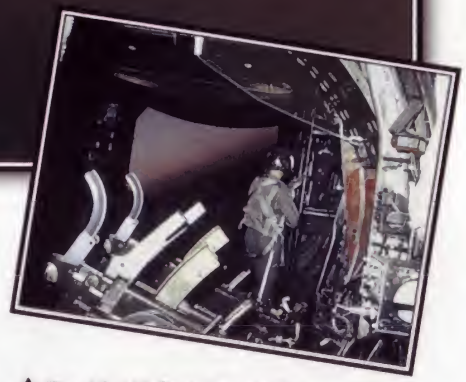
U-2R
Maximum speed 700 km/h (435 mph)

LOCKHEED

AC-130 SPECTRE

● Massive firepower ● Dangerous missions ● Advanced sensors





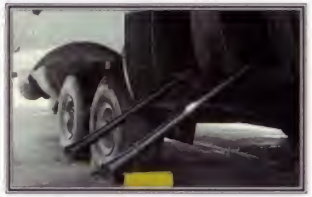
One of the most fearsome weapons to emerge from the war in Vietnam was the AC-130 Hercules gunship. Clever and elusive Viet Cong guerrillas, who were difficult enough to defeat in daylight, seemed to command the shadows of the night. The Spectre's task was to use its advanced sensors and hi-tech communications equipment to learn about enemy troop movements, and fire heavy guns to halt the enemy's advance.

▲ *The AC-130 Spectre was the ultimate gunship in Vietnam. Used in the interdiction war against the Ho Chi Minh Trail, it proved devastatingly effective at destroying supply lorries travelling from North to South Vietnam.*

PHOTO FILE

LOCKHEED AC-130 SPECTRE

▲ Sideways firing
All guns faced to port. By flying a tight turning circle the AC-130 could concentrate its devastating firepower on a small area.



▲ Gun armament
Project Surprise Package replaced a pair of the AC-130A's aft 20-mm (0.79-in) cannon with twin 40-mm (1.57-in) Bofors guns. These could destroy a lorry with a single round.

Bigger and better ▶
Faster and better armed and equipped, the AC-130 replaced previous gunship versions of the C-47 and C-119 transports.

▲ 105-mm howitzer
A howitzer, the US Army's standard field gun, was the heaviest and most awesome weapon carried.

Spectre sensors ▶
To hunt trucks and other vehicles in the dark, the AC-130 was fitted with a comprehensive range of night-vision and target acquisition sensors.

FACTS AND FIGURES

- The AC-130 programme began on 20 December 1967 with a USAF order for C-130s to be modified into gunships.
- Combat trials showed that the AC-130 was better at destroying trucks than the A-26.
- During the 1969/70 campaign, AC-130s destroyed 3384 enemy vehicles.
- On 24 January 1971, an AC-130 crew set a record of 58 lorries destroyed and seven damaged during one mission.
- In 1970 AC-130 crews prevented the Chin Loa special forces camp being overrun.
- AC-130s were used most recently by US forces in Iraq.

PROFILE

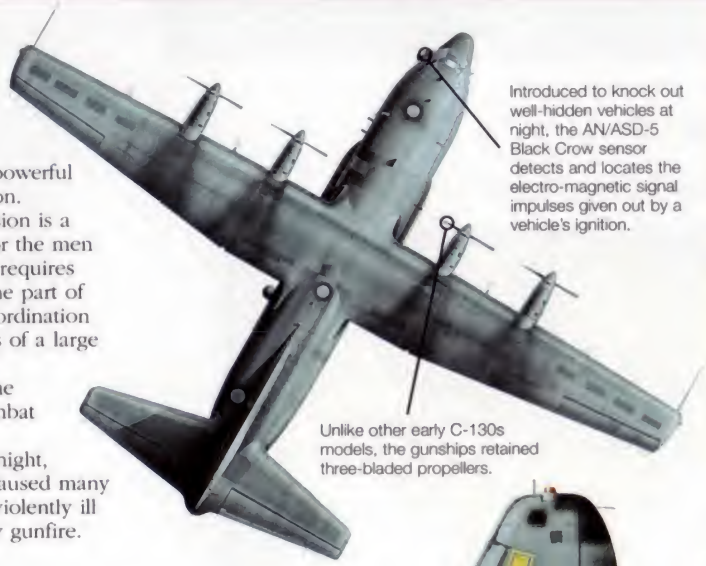
Gunship over the Trail

Vietnam was the proving ground for the aerial gunship. After the success of the Douglas AC-47 and Fairchild AC-119, the 'ultimate' gunship appeared on the scene – the Lockheed AC-130 Spectre.

From a distance, this warplane looks like the C-130 transport aircraft upon which it is based, except that it is painted in dark colours to blend into the night. Close-up, the AC-130 can be seen to be a potent fighting machine. With the port side of its fuselage turned towards the ground and flying in a tight pylon turn above the battlefield, the Spectre can unleash a barrage of gunfire from cannon and machine guns.

The AC-130 is slow compared to jet warplanes, and is vulnerable to gun or missile fire from the ground. But when the enemy has light, mobile forces, such as the Viet Cong guerrillas moving in a convoy of lorries along a supply trail deep in the Vietnamese jungle, the AC-130 Spectre is a powerful and terrifying weapon.

The gunship mission is a difficult challenge for the men who fly it. The task requires incredible skill on the part of the pilot, perfect coordination among the members of a large and busy crew and extreme courage. The rigours of flying combat missions inside an orbiting gunship at night, with no windows, caused many aircrew to become violently ill even without enemy gunfire.



Introduced to knock out well-hidden vehicles at night, the AN/ASD-5 Black Crow sensor detects and locates the electro-magnetic signal impulses given out by a vehicle's ignition.

Unlike other early C-130s models, the gunships retained three-bladed propellers.

AC-130A SPECTRE

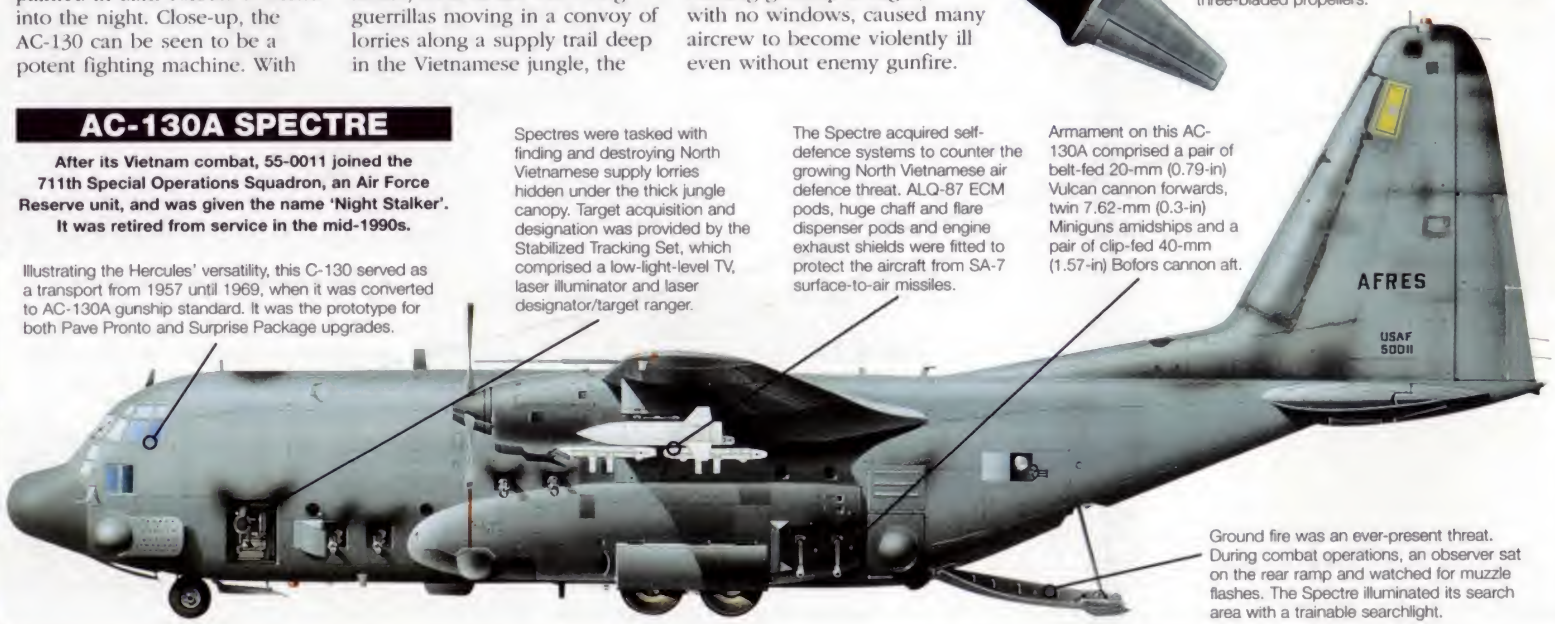
After its Vietnam combat, 55-0011 joined the 711th Special Operations Squadron, an Air Force Reserve unit, and was given the name 'Night Stalker'. It was retired from service in the mid-1990s.

Illustrating the Hercules' versatility, this C-130 served as a transport from 1957 until 1969, when it was converted to AC-130A gunship standard. It was the prototype for both Pave Pronto and Surprise Package upgrades.

Spectres were tasked with finding and destroying North Vietnamese supply lorries hidden under the thick jungle canopy. Target acquisition and designation was provided by the Stabilized Tracking Set, which comprised a low-light-level TV, laser illuminator and laser designator/target ranger.

The Spectre acquired self-defence systems to counter the growing North Vietnamese air defence threat. ALQ-87 ECM pods, huge chaff and flare dispenser pods and engine exhaust shields were fitted to protect the aircraft from SA-7 surface-to-air missiles.

Armament on this AC-130A comprised a pair of belt-fed 20-mm (0.79-in) Vulcan cannon forwards, twin 7.62-mm (0.3-in) Miniguns amidships and a pair of clip-fed 40-mm (1.57-in) Bofors cannon aft.



Ground fire was an ever-present threat. During combat operations, an observer sat on the rear ramp and watched for muzzle flashes. The Spectre illuminated its search area with a trainable searchlight.

AC-130A Spectre

Type: multi-sensor ground attack gunship

Powerplant: four 3020-kW (4,050-hp) Allison T56-A-7 turboprop engines

Maximum speed: 612 km/h (380 mph) at 10,000 m (32,808 ft)

Range: 3685 km (2,290 miles)

Service ceiling: 11,000 m (36,089 ft)

Weights: empty est. 36,000 kg (79,366 lb); maximum take-off 79,389 kg (175,023 lb)

Armament: early aircraft carried four 7.62-mm (0.3-in) Miniguns and four 20-mm (0.79-in) M61A1 Vulcan six-barrelled rotary cannon; later the Vulcans were replaced by two 40-mm (1.57-in) Bofors guns and two 20-mm T-171 multi-barrelled cannon

Dimensions:

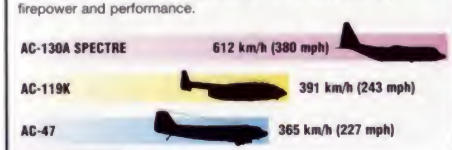
span	40.41 m (132 ft 7 in)
length	29.79 m (97 ft 9 in)
height	11.66 m (38 ft 3 in)
wing area	162.11 m² (1,745 sq ft)

Introduced in 1973, the overall gunship grey paint scheme gradually replaced the sinister black undersides and three-tone camouflage.

COMBAT DATA

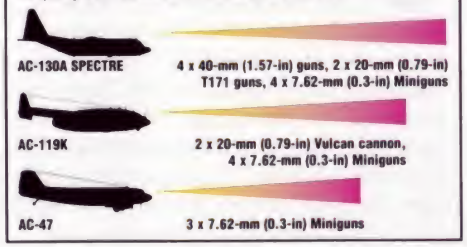
MAXIMUM SPEED

After pioneering gunship operations over Vietnam, the AC-47 was soon replaced by the AC-119 and, ultimately, the formidable AC-130A. Each aircraft represented an advance in avionics, firepower and performance.

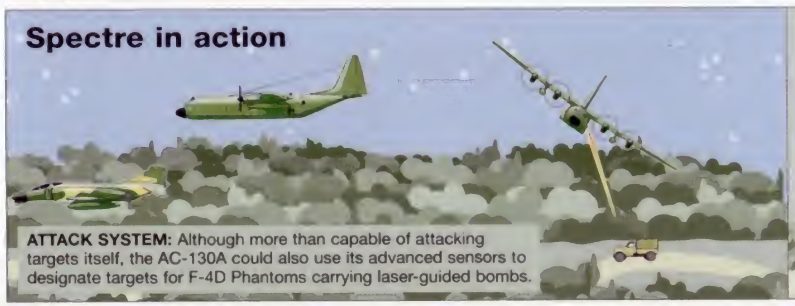


ARMAMENT

With its capacity for lifting heavy loads of freight, the Hercules was a natural choice for gunship conversion. It was able to carry heavy weaponry and thousands of rounds of ammunition.



Spectre in action



ATTACK SYSTEM: Although more than capable of attacking targets itself, the AC-130A could also use its advanced sensors to designate targets for F-4D Phantoms carrying laser-guided bombs.

1 SEARCHING THE TRAIL: Viet Cong lorries were difficult to find in the dense jungle of the Ho Chi Minh Trail. The AC-130A often remained on station for many hours, acquiring and attacking targets.

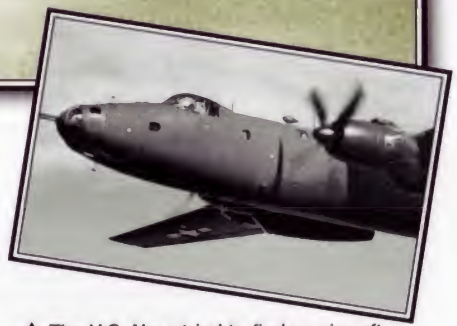
2 INVADER INTERDICTION: Few aircraft had the endurance or weapons load to fly all-night missions alongside the AC-130A. One aircraft particularly suitable for the task was the B-26K Invader.

MARTIN

P4M MERCATOR

● Dual piston/jet power ● Patrol bomber design ● 'Ferret' aircraft

One of the secrets of the Cold War would be a good way to describe the little-known Martin P4M Mercator. From outside, the Mercator resembled the better-known Lockheed Neptune patrol aircraft. Inside, it was very different. This twin-engine aircraft was actually designed from the beginning for four engines. Also, although designed for maritime patrol work, the Mercator spent most of its career as a spy in the sky.



▲ *The U.S. Navy tried to find an aircraft that could combine the range of a propeller-driven machine with the speed of a jet. The results were often an unsatisfactory compromise.*

PHOTO FILE

MARTIN **P4M MERCATOR**

◀ First production Mercator
The first production P4M-1 early on in its career; the main undercarriage did not retract fully into the Mercator's wing and was surrounded by a fairing on the lower wing surface.

▲ Last of 19
P4M-1 124373 was the last example off the production line. All became P4M-1Q 'ferrets'.

▲ Designed for speed and range
Like the Consolidated PB4Y before it, the P4M used a long, thin wing to provide fuel capacity and long range. The jet engines, while providing more speed, actually compromised range performance.

▲ Second XP4M-1
Aircraft 02790 was the second Mercator prototype. The J33 jet engine air intake is below the propeller, in the open position.

Three-blade propellers ▶
One of the two P4M prototypes is seen on an early flight. Note the three-blade propellers and lack of armament.

FACTS AND FIGURES

- The first XP4M flew on September 20, 1946, with three-blade propellers, not the four-blade type on later aircraft.
- In its brief service as a patrol aircraft, the P4M replaced the PB4Y Privateer.
- Chinese MiG fighters shot down a P4M near Shanghai on August 22, 1956.
- Production totaled 21 Mercators; two prototypes and 19 maritime patrol/radar reconnaissance conversions.
- Another P4M-1Q was damaged by North Korean MiG-17s on June 16, 1959.
- J33 engines also powered the USAF's first operational jet fighter, the P-80.

PROFILE

Naval bomber turned 'ferret'

Naval patrol missions were originally envisioned when the fabulous Glenn L. Martin Company designed the P4M Mercator.

Power provision in the P4M was unique. It had one piston and one jet engine on each side, each buried in the same engine nacelle, hanging from the wing. This gave the Mercator tremendous power and speed, as well as excellent range – exactly the qualities the US Navy needed in a patrol bomber.

The Mercator was a muscular aircraft. It was the only patrol ship in which a crew member could stand fully erect inside the fuselage. It was strong and heavy, and was extremely stable. For a brief period in the early 1950s, a few Mercators served with a single navy patrol squadron and these qualities produced excellent performance.

However, intelligence needs led the Navy to quickly decide to modify its small fleet of Mercators to spy on Soviet and Chinese radar transmitters. As a 'ferret', or radar reconnaissance aircraft, the Mercator was usually present when the Cold War heated up. One was shot down and another fired upon before the Mercator was retired from service in 1961.

Above: Martin's Model 219 was ordered on 6 July 1944 to fill a US Navy requirement for a patrol bomber. All Martin's previous naval bombers had been flying boats like the PBM Mariner.

Right: Only three units were ever equipped with the Mercator. The two SIGINT units were VQ-1 in the Pacific and VQ-2 in the Atlantic. From 1958, carrier-borne EA-3 Skywarriors performed a similar role.

P4M-1 Mercator

Type: maritime patrol aircraft

Powerplant: two 2423-kW (3250-hp) Pratt & Whitney R-4360-20A Wasp Major radial piston engines and two 20.5-kN (24,610-lb-thrust) Allison J33-A-10A turbojet engines

Maximum speed: 660 km/h (409 mph) at 6125 m (20,090 ft)

Range: 4570 km (2833 miles)

Service ceiling: 7666 m (25,145 ft)

Weights: maximum take-off 40,088 kg (88,194 lb); gross (approx.) 37,421 kg (82,326 lb)

Weapons: four 20-mm cannon; four 12.7-mm (.50-cal.) machine guns; plus up to 2722 kg (5988 lb) of bombs

Dimensions:

span	34.75 m (114 ft)
length	25.60 m (198 ft)
height	7.95 m (26 ft)
wing area	121.79 m² (1310 sq ft)

P4M-1 Mercator

Only 19 production P4Ms were built, and the only squadron equipped with the basic Dash-1 variant was Patrol Squadron VP-21. The first examples reached the squadron in June 1950.

The standard US Navy color scheme for its aircraft in the 1950s was this dark shade known as 'midnight blue'. Other than national and Navy markings. this P4M carries VP-21's 'HC' tail code and a number (below the cockpit) for identity within the unit.

The combination of two R-4360 radial piston engines and two Allison J33 turbojets gave the P4M a 660 km/h (409 mph) top speed and 4500-km (2790-mile) range. The J33 was positioned in the bottom half of the nacelle, breathing air from an intake below the propeller and exhausting to the rear of the nacelle, near the trailing edge of the wing.

Mercator was a cantilever high-wing monoplane with tricycle undercarriage. In the maritime reconnaissance role, the P4M lost out to the similarly configured Lockheed P2V Neptune, which went on to be built in large numbers.

The dorsal turret was equipped with two 12.7-mm (.50-cal.) machine guns; two more could be fuselage mounted, one on either side in the observer's position. The latter were not always carried.

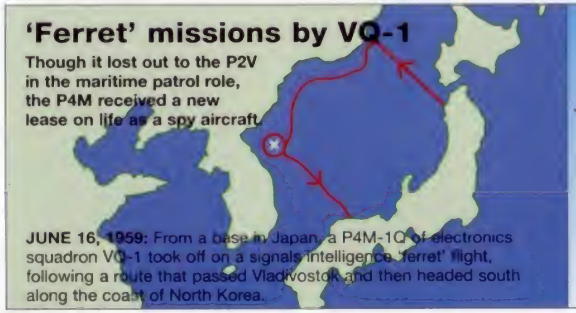
As built, P4M tail and nose turrets each carried twin 20-mm cannon for self-defence. These, plus the dorsal turret position, were manned during 'ferret' flights that took the craft close to Chinese, Soviet and North Korean territory.

In the 'ferret' signals intelligence role, the P4M-1Q had a crew of 14: pilot, co-pilot, navigator, electronics officer, six system operators, plane captain and three gunners.

External antennas, other than the two ventral radomes, indicate a SIGINT role.

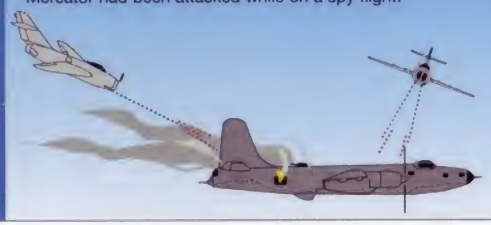
'Ferret' missions by VQ-1

Though it lost out to the P2V in the maritime patrol role, the P4M received a new lease on life as a spy aircraft.



JUNE 16, 1959: From a base in Japan, a P4M-1Q of electronics squadron VQ-1 took off on a signals intelligence 'ferret' flight, following a route that passed Vladivostok and then headed south along the coast of North Korea.

NORTH KOREA REACTS: North Korea reacted by sending two MiG-17 fighters to intercept the 'snooping' American aircraft. This was the second major incident in which a Mercator had been attacked while on a spy flight.



DAMAGE SUSTAINED: Unlike the Chinese incident of 1956, this attack left the Mercator damaged, but able to limp back to its base. The P4M continued in this role until 1960, in both the Atlantic and Pacific theaters.

ACTION DATA

RANGE

The P4M's piston engines gave it a range marginally better than the Privateer, but less than was possible if all-piston power had been used, as in the P2V Neptune. For a maritime patrol aircraft, good range means long endurance.

MCDONNELL

F-101A/C VOODOO

● Long-range interceptor ● Reconnaissance ● Tactical nuclear strike

Two pilots, the McDonnell Douglas F-101 Voodoo was a friendly monster. It was not a forgiving mount; in fact, it was one of the hardest-to-fly aircraft ever to serve in the US Air Force. But once a pilot learned its quirks, the Voodoo was an extravagant performer. Designed as a bomber escort, it became a tactical nuclear striker and an interceptor defending North America. But its greatest moments came in Southeast Asia, when reconnaissance versions flew history's fastest combat missions over North Vietnam.

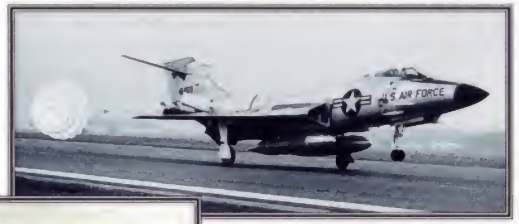
▲ *Voodoo crews lived exciting lives, flying a tricky aircraft with startling performance in roles such as one-way nuclear strike sorties and high-speed reconnaissance flights at treetop height.*

PHOTO FILE

MCDONNELL F-101A/C VOODOO

▲ Racing speed
When MiGs chased Voodoos in Vietnam, pilots usually selected afterburner and made a high-speed escape.

▲ More fuel
The original Voodoos used the standard USAF refuelling boom, but were unusual in having a probe for a drogue system as well.



◀ All stop
The Voodoo needed its brake chute, being fast and heavy. A field arrestor hook was also fitted for emergency landings at high speed.

◀ Escort fighter
The Voodoo was originally designed to fly long-range missions alongside nuclear bombers such as the B-47.

Flaps down ▶
The Voodoo was built to fly very fast, but its large split flaps and leading-edge flaps gave it good handling at low airspeed, even when fitted with large external fuel tanks.

FACTS AND FIGURES

- F-101A and F-101C models were designed to carry a nuclear weapon to the Soviet Union from air bases in Britain.
- A Korean War ace, Major Lonnie R. Moore, was killed in an F-101A crash.
- The RF-101C reconnaissance version was the only Voodoo to fight in Vietnam.
- The only export user of the Voodoo was Canada, which operated two batches of around 60 F-101B interceptors.
- In all, 480 two-seaters, known as TF-101B and F-101F, served as interceptors.
- Two-seat Voodoos in USAF service could carry the Genie nuclear air-to-air missile.

PROFILE

McDonnell's monster fighter

The Voodoo was possibly the first warplane to exceed supersonic speed on its first flight (on 29 September 1954), but it never became easy to fly. Tucking in the Voodoo's nosewheel was a challenge and the aircraft had a tendency to 'pitch up', for which various cures were attempted, never with success. It killed test pilots and challenged service pilots. It remained totally unforgiving throughout – but when used properly it was a world-beater.

Development of the F-101 Voodoo was drawn out because of its teething troubles, but its service career was also surprisingly long (1956–1987).

Daylight reconnaissance missions over Hanoi by the RF-101C routinely exceeded Mach 1.8, faster than any other aircraft has ever flown under fire. The two-seat F-101B interceptor, in both American and Canadian hands, was one of the most complex warplanes ever fielded, and was deemed a nightmare by mechanics – but it was able to intercept bombers thousands of kilometres from their targets.

The sleek shape of the F-101 was very close to the shape of the original XF-88 fighter design on which it was based. As with many designs of the 1950s, gains in performance were made at the cost of difficult handling.

The plan view is of a reconnaissance Voodoo, which differs from the fighter primarily in having a camera nose rather than radar.

The wing was fitted with 'fences'. These reduced induced drag by limiting the outward flow of air over the upper surface.

Voodoos were usually either all-metal in colour or finished in grey, but the reconnaissance machines in Vietnam received a brown and green jungle paint scheme.

F-101A Voodoo

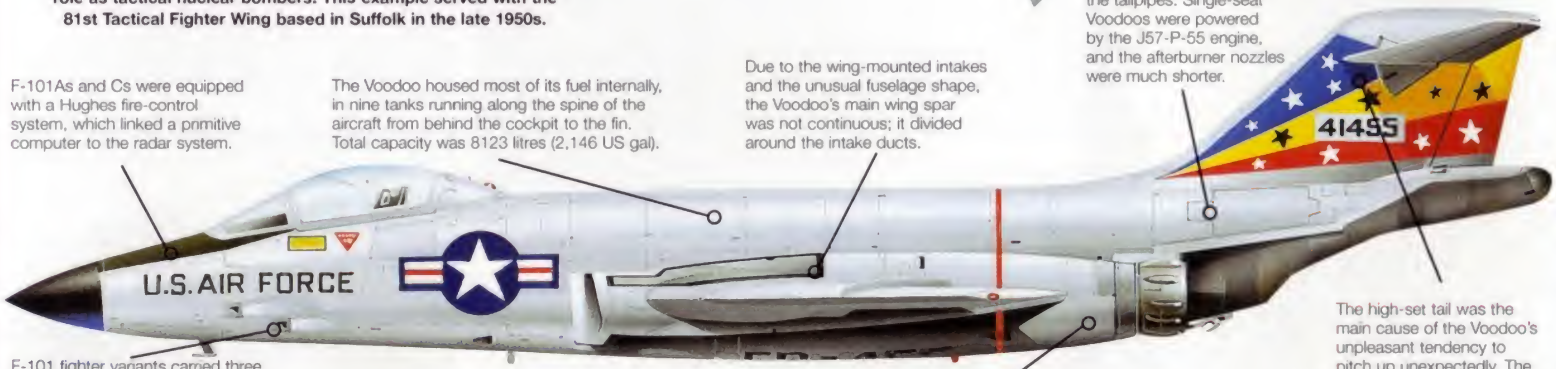
Designed as escort fighters, Voodoos were quickly adapted to a new role as tactical nuclear bombers. This example served with the 81st Tactical Fighter Wing based in Suffolk in the late 1950s.

The airbrakes were mounted on the upper rear fuselage sides, just above the tailpipes. Single-seat Voodoos were powered by the J57-P-55 engine, and the afterburner nozzles were much shorter.

F-101As and Cs were equipped with a Hughes fire-control system, which linked a primitive computer to the radar system.

The Voodoo housed most of its fuel internally, in nine tanks running along the spine of the aircraft from behind the cockpit to the fin. Total capacity was 8123 litres (2,146 US gal).

Due to the wing-mounted intakes and the unusual fuselage shape, the Voodoo's main wing spar was not continuous; it divided around the intake ducts.



F-101 fighter variants carried three M39 20-mm (0.79-in) cannon, two on the port side and one on the starboard side of the fuselage.

The J57 engine was a very powerful one for its day. It was not without its problems initially, being prone to compressor stalls.

The high-set tail was the main cause of the Voodoo's unpleasant tendency to pitch up unexpectedly. The tailplane was an all-moving unit, with a VHF antenna on top of the fin.

F-101A Voodoo

Type: single-seat tactical fighter bomber

Powerplant: two Pratt & Whitney J57-P-13 turbojets each rated at 66.20 kN (14,889 lb thrust) with maximum afterburner

Maximum speed: Mach 1.9 or 1982 km/h (1,232 mph) at 10,000 m (32,808 ft)

Range: 3040 km (1,889 miles)

Service ceiling: 15,850 m (52,000 ft)

Weights: empty 11,617 kg (25,611 lb); loaded 23,135 kg (51,004 lb)

Armament: four 20-mm (0.79-in) cannon, 3050 kg (6,724 lb) of bombs, including tactical nuclear weapons

Dimensions:

span	12.09 m (39 ft 8 in)
length	20.54 m (67 ft 5 in)
height	5.48 m (18 ft)
wing area	34.19 m² (368 sq ft)

COMBAT DATA

MAXIMUM SPEED

The Voodoo was one of the fastest fighters of its time, and considerably quicker than the contemporary British Hunter. The MiG-21 appeared several years later, and although faster at altitude it still could not match the sheer brute power of the Voodoo at low level.

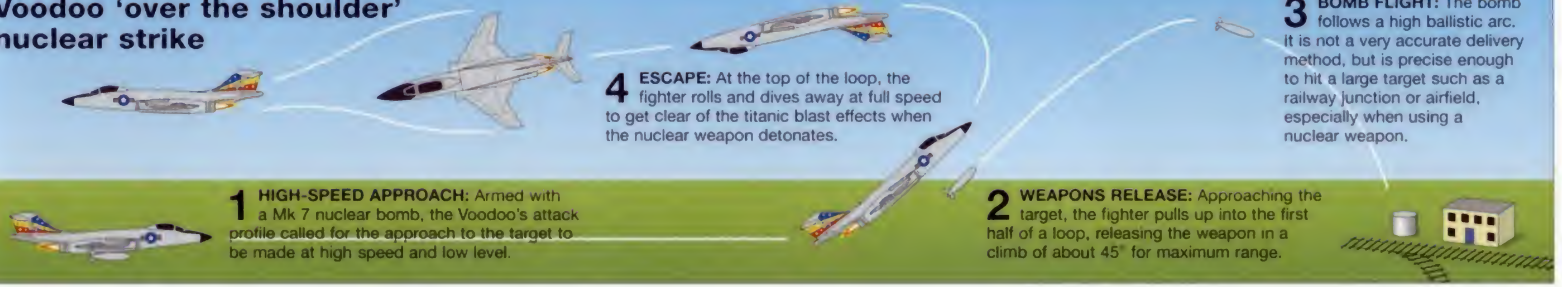
RANGE

The Voodoo was a very big fighter, and could carry a large amount of fuel. This meant that it had a very long range, and it was therefore ideally suited to long-range missions. Voodoos based in Britain during the Cold War were tasked with low-level nuclear strike, and were expected to destroy targets deep into Eastern Europe.

WARLOAD

The Voodoo carried a considerable bombload for a single-seat fighter of the 1950s. Its primary ground-attack mission called for the accurate delivery of large tactical nuclear weapons, but it could also deliver a wide variety of conventional weapons.

Voodoo 'over the shoulder' nuclear strike



1 HIGH-SPEED APPROACH: Armed with a Mk 7 nuclear bomb, the Voodoo's attack profile called for the approach to the target to be made at high speed and low level.

2 WEAPONS RELEASE: Approaching the target, the fighter pulls up into the first half of a loop, releasing the weapon in a climb of about 45° for maximum range.

3 BOMB FLIGHT: The bomb follows a high ballistic arc. It is not a very accurate delivery method, but is precise enough to hit a large target such as a railway junction or airfield, especially when using a nuclear weapon.

4 ESCAPE: At the top of the loop, the fighter rolls and dives away at full speed to get clear of the titanic blast effects when the nuclear weapon detonates.

MCDONNELL DOUGLAS

A-4 SKYHAWK

● Carrier-borne and land-based attack ● Defence suppression

▲ *Close support missions over Vietnam were fraught with risk. Many Skyhawks returned to their carrier or base with damage sustained during a tangle with Communist anti-aircraft defences.*

Skyhawk pilots in Vietnam went into battle relying on their ability and on their lightweight, nimble attack aircraft. The enemy waited, equipped with missiles, MiGs and thousands of anti-aircraft guns. The challenge for the Skyhawk pilot was to take off from a carrier deck or shore base, fly into hostile territory and attack a heavily defended target in North Vietnam. Navy and Marine Corps A-4s were among the most important attack aircraft of the war.

PHOTO FILE

MCDONNELL DOUGLAS A-4 SKYHAWK

◀ With the Corps at Chu Lai
US Marine Corps A-4s flew close support missions from shore bases. A ground catapult system called SATS was used at Chu Lai.

▼ Heading back to the carrier
An A-4F of VA-144 'Roadrunners' returns to the USS Bonne Homme Richard. *Heavy losses were sustained over North Vietnam.*

▼ In action throughout Vietnam War
Although A-4s were replaced in carrier-based attack units from 1967, they continued to operate from small 'Essex'-class carriers.

▼ Iron Hand – the anti-radiation mission
Carrying a pair of AGM-45 Shrike anti-radiation missiles and a bomb, this A-4F, distinguished by its dorsal avionics hump, prepares for a 'cat shot'. Flak and surfake-to-air missile suppression missions were among the most dangerous of those performed by A-4s.

◀ 20-mm cannon
An armourer replenishes a Skyhawk's Colt cannon ammunition. Cannon were effective for ground-attack strafing, but enemy SAMs soon made low-level missions too risky.

FACTS AND FIGURES

- An A-4 pilot killed while attacking missile sites was one of only two naval aviators awarded the Medal of Honor in Vietnam.
- 'Heinemann's Hot Rod' and 'Scooter' are just two of the A-4's many nicknames.
- The first A-4 entered US Navy service in 1955; action in Vietnam began in 1964.
- The Skyhawk was replaced by the Vought A-7 Corsair II as the US Navy's standard attack aircraft.
- Just before the Vietnam War, the US Army evaluated the A-4 for close air support.
- The Marine Corps used a few two-seat Skyhawks for combat observation duties.

PROFILE

'Scooters' over Indo-China

Edward Heinemann, Douglas's chief designer, wanted to produce a formidable warplane small enough to fit on an aircraft-carrier deck without having to fold its wings.

The A-4 Skyhawk was designed for a nuclear mission. Originally, it was intended to carry a single atomic bomb on a centreline rack beneath the fuselage, but the Navy and Marine Corps always saw the type with an additional role as a conventional bomber.

From the start of its flight test programme in the early 1950s, the A-4 carried a variety of conventional bombs, rockets and missiles. When the United States launched its first air strike against North Vietnam in August 1964, the 'Scooter' was there.

In the years that followed, A-4s flew from US Navy carriers and land bases (with the Navy and Marines) to support troops in South Vietnam and to hit targets in the North. Attacks were of two types: major strikes on predetermined targets, involving aircraft from more than one unit, and interdiction missions by small numbers of aircraft attacking targets of opportunity. Among the most risky roles was defence suppression, using cluster bombs and ARMs.

Although the A-4 was an air-to-surface machine, air-to-air encounters were not unheard of. One Skyhawk even shot down a MiG-17 with a Zuni air-to-ground rocket barrage.

After low-level attacks proved too risky, Communist targets were approached at high speed from high altitude, and bombed in shallow diving attacks.

Centreline and wing fuel tanks were often carried on A-4 missions, thereby reducing warload. In-flight refuelling was also possible via the nose-mounted air-to-air probe.

Essentially a 'cropped delta', the A-4's wing span was just 8.38 m (27 ft 6 in). This meant that a folding wing was not required for storage aboard an aircraft-carrier.

A-4E Skyhawk

BuNo. 149993 served with Attack Squadron 72 (VA-72) 'Blue Hawks' aboard the USS *Independence* in the South China Sea in May 1965. VA-72 was the first US Navy unit to operate Skyhawks, receiving A4D-1s in 1956.

The A-4E was the first Skyhawk variant optimized for air support and conventional bombing rather than the nuclear mission. New equipment included tactical air navigation (TACAN), Doppler navigation, a radio altimeter and new toss-bombing and low-altitude bombing systems.

Originally intended for the cancelled A4D-3 all-weather variant, the Pratt & Whitney J52 turbojet made its debut in the A-4E (designated A4D-5 during development). Its lower fuel consumption increased range by 27 per cent.

For a 'cat shot' from a carrier, the Skyhawk was connected to the catapult shuttle by cables attached to the main undercarriage. For Marine Corps land-based operations the Short Airfield Tactical Support (SATS) was used. This consisted of a 674-m (2,211-ft) (aluminium runway and required rocket-assisted take-offs (RATOs) plus arresting gear for landings.

This aircraft carries three 227-kg (500-lb) Mk 82 Snakeye high-drag bombs. The A-4 was able to carry a variety of weapons, up to a load capacity of around 4500 kg (9,920 lb). Two additional hardpoints were fitted on the A-4E and the aircraft's structure was strengthened to a catapult gross weight of 11,113 kg (25,000 lb).

A-4E Skyhawk

Type: single-seat attack aircraft

Powerplant: one 41.37-kN (9,305-lb-thrust) Pratt & Whitney J52-P-8A turbojet engine

Maximum speed: 1083 km/h (673 mph) at sea level

Combat radius: 612 km (380 miles)

Range: 1480 km (920 miles)

Service ceiling: 11,400 m (37,402 ft)

Weights: empty 4581 kg (10,099 lb); maximum take-off 12,437 kg (27,419 lb)

Armament: two 20-mm (0.79-in) Mk 12 cannon, each with 200 (later 400) rounds, provision for up to four LAU-10A rocket pods containing Zuni air-to-ground projectiles; up to four Martin Marietta AGM-12A Bullpup-A air-to-surface guided missiles or up to 4491 kg (9,900 lb) of bombs

Dimensions:

span	8.38 m (27 ft 6 in)
fuselage length	12.29 m (40 ft 4 in)
height	4.57 m (15 ft)
wing area	24.16 m² (260 sq ft)

COMBAT DATA

MAXIMUM SPEED AT SEA LEVEL

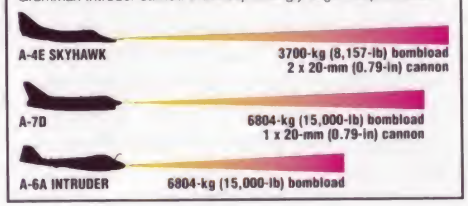
Although slower than the Skyhawk, the Vought A-7 had a considerably greater weapons load. Both the USAF and Navy operated the type in Vietnam. The twin-engined, two-seat Intruder was marginally quicker and a much more sophisticated aircraft.

CLIMB RATE

Land-based A-7s and Intruders had a much better initial climb rate than the Skyhawk. Carrier-based aircraft are hampered by their limited launch speeds, which greatly restrict climb rate.

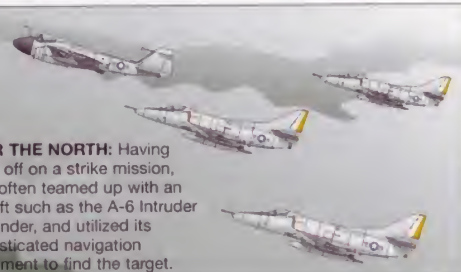
ARMAMENT

Operating from land bases, the A-7D was able to lift a much larger load than the A-4. This load-carrying capacity also impressed the Navy, which adopted the type from the late 1960s. The larger Grumman Intruder carried a correspondingly large weapon load.

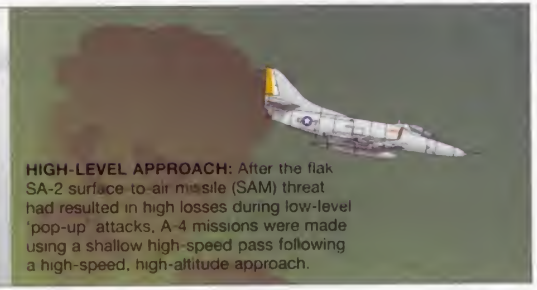


Skyhawks over 'Nam

MARINE CORPS 'SCOOTERS': USMC Skyhawks used the Short Airfield Tactical Support RATO take-off/arrested recovery system, which allowed them to operate from cramped airstrips such as Chu Lai.



OVER THE NORTH: Having taken off on a strike mission, A-4s often teamed up with an aircraft such as the A-6 Intruder pathfinder, and utilized its sophisticated navigation equipment to find the target.



HIGH-LEVEL APPROACH: After the flak SA-2 surface-to-air missile (SAM) threat had resulted in high losses during low-level 'pop-up' attacks, A-4 missions were made using a shallow high-speed pass following a high-speed, high-altitude approach.

MCDONNELL DOUGLAS

F-4 PHANTOM II (US NAVY)

● Classic carrier fighter ● MiG-killer ● Ground-attack capability

▲ *McDonnell's incredible warplane began life as a shipboard interceptor with the US Navy, and it is perhaps these examples which are the true classic Phantom variants.*

McDonnell's F-4 Phantom II was developed to meet a US Navy need for an interceptor to defend its aircraft-carriers from attack. After the Phantom became operational, it grew into a multi-role warplane with many capabilities – all of them superior. The Phantom could fight MiGs and drop bombs. It was bigger, heavier, more powerful, faster and further-reaching than any other contemporary combat aircraft.

PHOTO FILE

MCDONNELL DOUGLAS F-4 PHANTOM II

◀ More capable variant
By the early 1970s, most Navy units had re-equipped with the more capable F-4J, which boasted a number of improvements, including more powerful engines and a datalink system.

▼ Launch the Phantom
A trio of F-4Bs from VF-102 'Diamondbacks' prepares for launch from one of the bow catapults on the USS Enterprise. Both the carrier and this squadron later saw combat in Southeast Asia.

▲ Armament
Operating primarily as fleet defence fighters, USN F-4s were seen most often carrying Sparrow and Sidewinder AAMs. The wing fuel tanks were seldom fitted.

▲ Smoky engines
This flypast fully illustrates the characteristic smoke trails which were a Phantom trademark.

◀ Trapping aboard 'Connie'
After a routine combat air patrol, a VF-92 F-4J lands aboard USS Constellation in 1974.

FACTS AND FIGURES

- Only the larger US Navy carriers could operate Phantoms. The aircraft were too heavy for 'Essex'-class carriers.
- Unlike their USAF counterparts, Navy F-4s were never fitted with guns.
- Lieutenant Randy Cunningham was the USN's only Phantom ace in Vietnam.
- In 1967 a Zuni rocket was accidentally fired on the deck of USS *Forrestal;* the resulting fire claimed a number of F-4s.
- Some USN F-4Js were later refurbished and delivered to the RAF.
- Grumman F-14 Tomcats began to supplant Phantoms in the mid-1970s.

PROFILE

Elite of the US Navy

In the early 1960s, the Phantom was the hottest thing in the sky. To show off its new fighter, the US Navy flew the new craft faster and higher than any operational warplane had gone before. Typical was a world altitude record of 30,218 m (99,140 ft). In 1961 a specially prepared Phantom reached 2585.15 km/h (1,606.34 mph). Not surprisingly, the Phantom was already becoming vital to US naval aviation when the American role in Vietnam expanded during the mid-1960s.

Phantoms participated in the first US air strikes against North Vietnam and were still around at the end of the war a dozen years later. For the pilot and radar intercept officer of a Phantom, part of the challenge consisted of taking off from and landing on an aircraft-carrier deck, sometimes at night, sometimes in bad weather. High over Hanoi, Phantoms faced North Vietnamese MiG-17 and MiG-21 fighters and fought well.

The US Navy's only ace pilot of the war flew a Phantom.

Above: With afterburners blazing, a VF-41 Phantom hurtles skyward. This unit was one of several Atlantic Fleet squadrons deployed on combat cruises to the Gulf of Tonkin.

Other Phantoms were operated from land bases in South Vietnam by US Marine crews. Long after Vietnam, the Phantom retained a key position in US naval aviation until its eventual retirement in the 1980s.

Below: This quartet of F-4Bs, belonging to VF-21 'Freelancers', is shown posing for the camera. The wing fuel tanks are unusual.

F-4B Phantom II

Type: two-seat carrier-borne interceptor

Powerplant: two 79.65-kN (17,914-lb-thrust) General Electric J79-8A afterburning turbojets

Maximum speed: 2390 km/h (1,485 mph)

Combat radius: 1450 km (901 miles)

Range: 3700 km (2,299 miles)

Service ceiling: 21,640 m (71,000 ft)

Weights: empty 12,701 kg (28,000 lb); maximum take-off 24,766 kg (54,600 lb)

Armament: four AIM-7 Sparrow medium-range and four AIM-9 Sidewinder short-range air-to-air missiles, plus various air-to-ground stores

Dimensions:

span	11.71 m (38 ft 5 in)
length	17.75 m (58 ft 3 in)
height	4.95 m (16 ft 3 in)
wing area	49.24 m² (530 sq ft)

F-4B Phantom II

Carrying a full load of Mk 82 bombs, this F-4B is depicted as it would have appeared during its first Vietnam cruise with VF-84 'Jolly Rogers' on board the USS *Independence* in late 1965. During this cruise, the squadron lost three aircraft in combat.

Unlike USAF Phantoms, the F-4B could not be flown from the rear cockpit. In Navy parlance, the backseater was the RIO (Radar Intercept Officer), whose job it was to operate the weapons system.

Sufficient clearance for the twin J79 engines resulted in the distinctive bulky profile, which gave rise to the type's nickname 'Double Ugly'. Above the engines were the fuselage fuel cells.

Early in their service careers, F-4Bs featured slick fin-tips, although later most aircraft were retro-fitted with radar homing and warning receiver (RHAW) antennas housed in distinctive bullet fairings facing both fore and aft.

As the first major production Phantom variant, the F-4B featured a Westinghouse APQ-72 radar, which was state of the art in 1965. A small undernose pod housed an infra-red seeker, although this was removed from the F-4J.

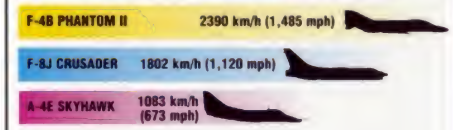
The medium-range AIM-7 Sparrow air-to-air missile was designed as part of the F-4's weapons system. When it was working, the Sparrow was an excellent missile, although in Vietnam it was prone to malfunctioning.

Although used by the Navy primarily as an interceptor, the F-4B was wired to carry air-to-ground weapons. As the war in Southeast Asia intensified, USN Phantoms were often seen flying bombing missions over North Vietnam, especially when there were not sufficient attack aircraft available. Most F-4 crews despised bombing sorties.

COMBAT DATA

MAXIMUM SPEED

During the 1960s the F-4's main rival in the naval fighter stakes was the Vought F-8 Crusader. The Crusader was often overrated because it was a single-seat fighter with guns. The Phantom was considerably faster thanks to its powerful twin J79 turbojets.



COMBAT RADIUS

Operational radius was where the Phantom came up short. It was a thirsty beast and needed regular air-to-air refuelling. By contrast, the smaller Crusader and even smaller Skyhawk were longer-legged, an important factor when flying sorties deep into the heart of North Vietnam.

MAXIMUM WEIGHT

Among its many records, the Phantom had the distinction of being the heaviest fighter to have served aboard a carrier up to that time. This weight factor prolonged the career of the F-8, which continued to operate from the smaller wooden-deck carriers.

US Navy Phantom MiG-killers in Vietnam

VF-161: During Operation Linebacker in May 1972, two F-4Bs from VF-161 'Chargers' tangled with two MiG-19s, downing both. The victorious crews, Lts Brown, Bartholomy, Arwood and Bell, are seen back in the squadron ready room.

VF-92: 10 May 1972 saw a number of MiG-kills for US Navy Phantoms. Lt Curt Dose of VF-92 'Silver Kings' successfully despatched an NVAF MiG-17 with an AIM-9 Sidewinder, and is seen here describing his tangle.

VF-114: Seen in high spirits after his return to the USS *Kitty Hawk*, Lt Robert Hughes, and his RIO Lt (jg) Adolph Cruz, managed to shoot down a MIG-21 on 6 May 1972. Hughes's wingman also scored a kill during the same successful sortie.

MCDONNELL DOUGLAS

F-4 PHANTOM II (USAF)

● Two-seat fighter-bomber ● War veteran ● Thirty years of service

Arguably the greatest warplane of its era, the McDonnell Douglas F-4 Phantom II was designed as a naval aircraft. When the US Air Force adopted the Phantom, airmen had to swallow their pride and fly a plane that the Navy had used first. The USAF was so impressed, however, that it bought more than 2000 examples; the 'Phabulous Phantom' was to form the backbone of Tactical Air Command for 20 years. Indeed, USAF F-4s both began and ended their service in a war zone – Vietnam in the 1960s and the Gulf in the 1990s.

▲ *Reputedly described by one USAF general as looking as though it was 'delivered upside-down', the Phantom could never be described as 'good-looking'. However, its years of mainly trouble-free service inspired admiration from those associated with it.*

PHOTO FILE

MCDONNELL DOUGLAS F-4 PHANTOM II (USAF)

▼ Reconnaissance Phantom

Over 500 RF-4Cs were delivered from 1964 to 1973, and except for the F-4E it was in production the longest. As built, the RF-4Cs were unarmed, although they could deliver an atomic weapon.

▼ Gun-toting F-4E

With its internal M61 cannon the F-4E was the last and most widely used version. Almost 1400 were built, with many being exported.

▲ F-4D takes on fuel

USAF Phantoms differed from Navy F-4s in using 'boom' air-to-air refuelling rather than the 'probe and drogue' system. The 'D' was the second USAF version, but the first purpose-designed for the Air Force.

▲ Precision-guided weaponry

In Vietnam USAF F-4s pioneered the use of precision-guided munitions. Here an F-4E delivers a TV-guided GBU-15 glide bomb.

▼ Advanced 'Wild Weasel'

The F-4G was the USAF's last variant of the Phantom and was also the last in service. In all, 134 'Wild Weasels' were converted from F-4Es.

FACTS AND FIGURES

- While the Vietnam War was under way, the F-4E equipped the 'Thunderbirds' USAF flight display aerobatic team.
- All five US aces in Vietnam, three of whom served in the USAF, flew the F-4.
- In the F-4G, based on the F-4E, the M61 gun was replaced by a radar detector.
- Now displayed in Colorado, one F-4 shot down six Vietnamese MiGs; no other F-4 was credited with more than three.
- Over 5100 Phantoms were built, with the USAF being by far the largest operator.
- The M61 20-mm cannon in the F-4E had a rate of fire of 100 rounds per second.

PROFILE

Thirty years of USAF Phantoms

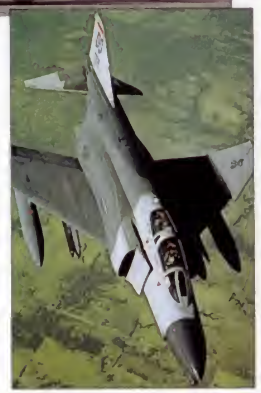
US Air Force generals were so impressed by the US Navy's F-4 that in March 1962 they decided that it would be the standard fighter for their tactical squadrons.

Three years later, F-4s began their campaign against MiG fighters in the skies over Hanoi. MiG-17s and MiG-21s were smaller, simpler and more nimble than the robust and ungraceful Phantom – but the F-4 entered each dogfight with brute force and power. The Vietnam War proved the merit of the Phantom, not just in air-to-air combat, but also in nearly every military job a jet aircraft could perform, including close support, bombing and reconnaissance.

While the first F-4C (from which a camera-equipped tactical reconnaissance RF-4C variant was also developed) was a minimum-change version of the Navy's F-4B, the F-4D introduced many improvements, mainly to enhance air-to-ground capability. 'Smart' weapons could now be delivered by F-4s.

The lack of an internal gun was addressed in the F-4E – the ultimate model – more than 800 of which entered USAF service. In all, more than 2200 F-4s flew with the Air Force, many operating in Vietnam.

The 'E'-model was to serve as the basis for the last USAF F-4s, the F-4G 'Wild Weasel' defence-suppression aircraft. These and RF-4Cs saw active duty in the 1990/91 Gulf War in the twilight of the Phantom's career. The last Phantoms were retired from the USAF in March 1996.



Above: Before their own Phantoms had been delivered, the USAF borrowed 29 US Navy F4H-1s. The first two carried 'F-110A' paintwork.

Right: Starting in 1967 the more capable F-4D replaced the F-4C in Vietnam. From the late 1970s many D variants went to Air National Guard and Reserve units, the last examples being retired in 1990. This aircraft wears the two-tone grey colour scheme adopted during the 1980s.

F-4E Phantom II

Type: two-seat multi-role fighter

Powerplant: two 79.6-kN (17,903-lb-thrust) General Electric J79-GE-17 afterburning turbojets

Maximum speed: 2304 km/h (1,432 mph) or Mach 2.17

Ferry range: 2593 km (1,611 miles)

Service ceiling: 18,975 m (62,254 ft)

Weights: empty 13,770 kg (30,358 lb); maximum loaded 28,055 kg (61,851 lb)

Armament: one M61A1 Vulcan 20-mm (0.79-in) cannon with 639 rounds and up to 7258 kg (16,000 lb) of ordnance, including four AIM-7 Sparrow and four AIM-9 Sidewinder missiles, plus a wide variety of bombs, rockets and precision-guided munitions

Dimensions:

span	11.68 m (38 ft 4 in)
length	19.20 m (63 ft)
height	5.00 m (16 ft 5 in)
wing area	49.24 m² (530 sq ft)

F-4E Phantom II

67-0308 was delivered in September 1968 and in October went to the 388th Tactical Fighter Wing (TFW) at Korat Air Force Base, Thailand, the first unit to use the F-4E in the war zone. It returned to the United States in 1973.

All Phantoms had two crew and many had dual controls. USAF aircraft carry a pilot and Weapons System Officer (WSO, or 'Wizzo', or 'Bear' in the F-4G). Initially the USAF wanted to equip their F-4s with two qualified pilots, an expensive option which was later abandoned.

Vietnam-era camouflage retained gull-grey undersides as applied to USAF F-4s from the beginning, but added a mixture of greens and tan to the upper surface.

The reshaped nose of the F-4E housed a Westinghouse APQ-120 radar set, which had a smaller dish than earlier Phantom radars. The shark's teeth were a 388th TFW trademark.

Shortcomings in the concept of a gunless fighter saw the installation of a General Electric M61 Vulcan six-barrel, 20-mm (0.79-in) rotary cannon in the nose of the F-4E.

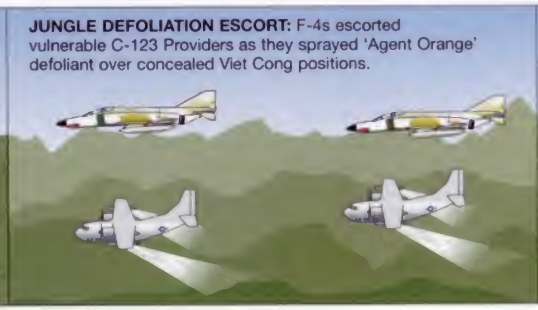
Primary defensive armament for USAF Phantoms was the AIM-7 Sparrow medium-range and AIM-9 Sidewinder short-range air-to-air missiles; typically four of each were carried.

Pratt & Whitney J79 afterburning turbojet engines powered all USAF F-4s. In later years the F-4G's engines were modified to reduce smoke.

All F-4s carried a tailhook, a legacy of their carrier-borne origins. Land-based aircraft could use the hook if their braking systems or undercarriage failed.

Phantoms in Vietnam

HAM RUNG BRIDGE: On 27 April 1972 F-4s of the 8th TFW used laser-guided bombs to destroy this difficult target at Thanh Hoa.



JUNGLE DEFOLIATION ESCORT: F-4s escorted vulnerable C-123 Providers as they sprayed 'Agent Orange' defoliant over concealed Viet Cong positions.

RECONNAISSANCE: RF-4Cs flew high-speed, unarmed reconnaissance missions over North Vietnam, avoiding SA-2 missiles and gunfire.

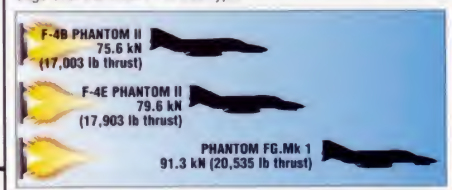
COMBAT DATA

MAXIMUM SPEED

Although all Phantoms had very good performance, the F-4E with its uprated engines was the best performer. The Rolls-Royce-engined British FG.Mk 1 was slightly slower than the others.

ENGINE THRUST

The large, fuel-thirsty engines of the naval FG.Mk 1 gave it more thrust than the American marks. The later model F-4E has a slight edge over the older F-4B sub-type.



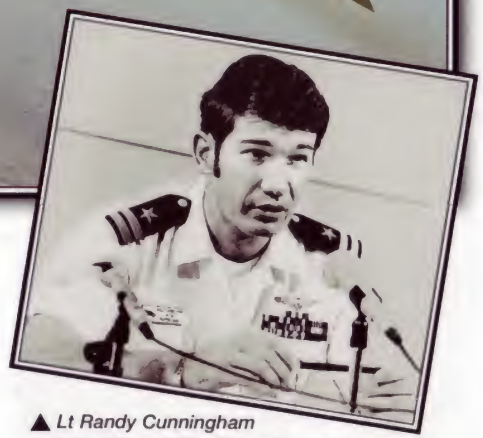
SERVICE CEILING

The land-based USAF Phantom IIs are in a league of their own when it comes to altitude. The British FG.Mk 1's heavier engines led to a fuselage redesign, producing slower speed, a reduced weapons load and a lower service ceiling.

MCDONNELL DOUGLAS

F-4 PHANTOM II (VIETNAM)

● Vietnam warrior ● Fighter and bomber ● MiG-killer supreme



▲ *Lt Randy Cunningham and his RIO Lt Willie Driscoll scored their third, fourth and fifth kills on 10 May 1972 to become the Navy's only aces of the war in Southeast Asia.*

The Phantom broke all the rules. Fighters were supposed to be small, sleek single-seaters with guns; the Phantom was huge and had bent wings, a two-man crew and missile armament. It looked wrong, but it flew right. Strapped inside Phantom cockpits over Vietnam, naval aviators fought MiGs in raging air combat and, after early problems, came out on top almost every time.

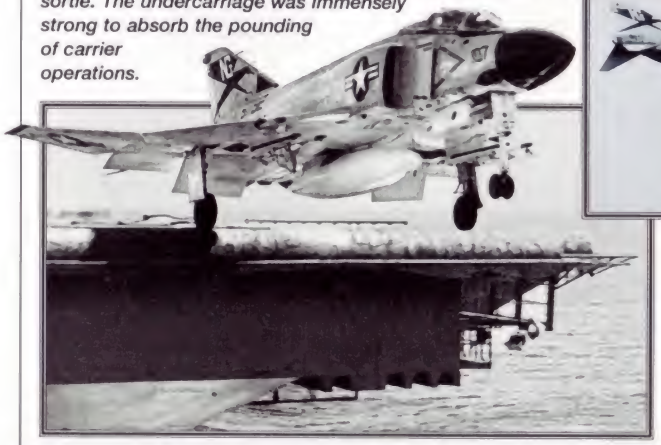
PHOTO FILE

MCDONNELL DOUGLAS F-4 PHANTOM II

▼ Top Guns of the 1960s
In the late 1960s the F-4 Phantom crew was considered the elite of the West's air forces. No service trained its crews better than the US Navy.

▲ Marines at sea
It wasn't just the Navy which flew the Phantom from aircraft-carriers. US Marine Corps squadrons shared the load of shipboard deployments.

▼ Catapult launch
An F-4J thunders from the deck on an unarmed training sortie. The undercarriage was immensely strong to absorb the pounding of carrier operations.



▲ Fighter-bomber
The Phantom was best known as a MiG-killer, but it did its fair share of ground-attacking as well. These aircraft are seen over Vietnam, dropping 227-kg (500-lb) bombs from the relative safety of medium altitude.

FACTS AND FIGURES

- Tests showed that pilots in Vietnam were more anxious about landing on the carrier than about fighting MiGs.
- Navy and Marine F-4B and F-4J fighters flew over 100,000 sorties in Vietnam.
- In early Vietnam combat, Phantom pilots were achieving only a 1:1 kill ratio.
- A Phantom weighs 4.68 times as much as the Hellcat carrier fighter of 1944.
- After the introduction of 'Top Gun' training, the kill ratio improved to as much as seven MiGs for each F-4 lost.
- On 10 May 1972 Navy F-4s from fighter squadron VF-96 downed six MiGs.

PROFILE

US Navy MiG-killers

Few human exploits compare with fighting in the F-4 Phantom. The big, powerful machine gave both pilot and radar officer the ride of their lives, blasting aloft with twice as much power as other fighters and going into battle armed to the teeth.

Randy Cunningham and Willie Driscoll were the first American aces in Vietnam, making three kills in the great air battles of 10 May. Their first kill, however, had come on 18 January while escorting an A-6 strike against Qhan Lang. After dodging surface-to-air missiles, they noticed two aircraft about four miles ahead.

'As we closed, I saw they were delta-winged MiG-21s, at about 500 feet [150 metres]. Just as I squeezed off a Sidewinder, my MiG broke into a hard turn. I could see my adversary's head thrashing around in the cockpit.'

After a series of manoeuvres, Cunningham found himself directly behind the MiG, and he fired again.

'Just as his wings levelled, the Sidewinder hit: the tail came off and the airplane went tumbling into the ground, creating a huge fireball.'

'Showtime 100' was the Phantom used by Randy Cunningham and Willie Driscoll on 10 May to score their three kills. The last was an epic battle against Colonel Tomb, reputedly the leading North Vietnamese ace. On the way home, 'Showtime 100' took a SAM hit and the crew had to bail out, but they were rescued safely.

Two crewmen meant an extra pair of eyes, which was a real advantage in a close-range, visual dogfight.

For air-to-air work the Phantom carried four short-range heat-seeking Sidewinders on the wing pylons.

F-4J Phantom II

Type: two-seat carrier-based multi-role fighter

Powerplant: two 79.63-kN (17,910-lb-thrust) General Electric J79-GE-10 turbojets with afterburners

Maximum speed: Mach 2.25 or 2390 km/h (1,485 mph)

Combat radius: 950 km (590 miles)

Service ceiling: 19,000 m (62,336 ft)

Weights: empty 13,250 kg (29,211 lb); loaded 27,655 kg (60,969 lb)

Armament: typically, four AIM-7 Sparrow radar missiles and four AIM-9 Sidewinder infra-red missiles; up to 1370 kg (3,020 lb) of bombs beneath fuselage and up to 5888 kg (12,980 lb) of bombs under wings

Dimensions:

span	11.71 m	(38 ft 5 in)
length	18.96 m	(62 ft 2 in)
height	5.03 m	(16 ft 6 in)
wing area	49.24 m²	(530 sq ft)

F-4J Phantom II

By 1972, when Cunningham and Driscoll flew this aircraft to their three MiG victories, the F-4J was the standard shipboard fighter for the US Navy. Because of its size it could fly only from the larger carriers, and could not fit on the small 'Essex'-class ships.

In 1965, carrier fighter squadron VF-96 scored the US Navy's first MiG kill of the Vietnam War. That was the unit's only success until 1972, when its crews downed a further eight MiGs, including five by the ace team of Cunningham and Driscoll.

For protection, the F-4 was fitted with a radar-homing and warning system, which detected enemy-surveillance and fire-control radars. The antennas were housed in the tip of the fin.

The Phantom had a superb radar in the shape of the APG-59. This was the best in the world at the time, and could track both low- and high-altitude targets.

To launch, the F-4 was hooked to the catapult with a heavy cable bridle which fell away when the aircraft left the deck.

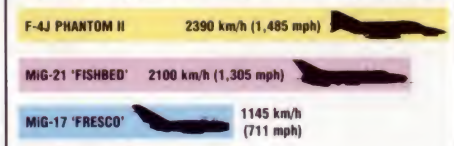
To highlight the secondary attack role of the Phantom, this aircraft carries cluster bombs.

The jetpipes of the Phantom were angled down to give an extra punch for carrier take-offs. The arrestor hook for stopping the aircraft was between the two engines.

COMBAT DATA

MAXIMUM SPEED

The Phantom's sheer power gave it tremendous speed, but it was very much a straight-line machine. Although by no means a dogfighter, the F-4's climbing, diving and acceleration ability were used to advantage against slower but much more agile opponents.

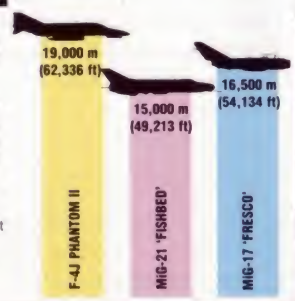


ARMAMENT

American rules of engagement in Vietnam meant that F-4 pilots had to visually identify the enemy before firing, negating their long-range missiles. And in a dogfight, the lack of a gun was a severe handicap which only good training could overcome.

SERVICE CEILING

The combination of immense power and a large wing area meant that the F-4 could reach exceptionally high altitudes. With its missile armament, the F-4 made an excellent bomber interceptor. In Vietnam, however, its opponents were agile fighters, but Phantom pilots could usually get out of trouble with MiGs by outclimbing their less powerful opponents.



MiG-killers of 10 May 1972

THE NAVY TAKES ON THE MiGs: 10 May 1972 was the Navy Phantom's big day over Vietnam. Flying from USS *Constellation*, sister squadrons VF-92 'Silver Kings' and VF-96 'Fighting Falcons' blasted seven MiGs from the skies between them, while a VF-51 crew shot down another for the Navy. To make matters worse for the North Vietnamese, USAF Phantoms accounted for another three MiGs that fateful day.

FIRST KILL OF THE DAY: Lt Curt Dose (seen here demonstrating his dogfight) and Lt James McDevitt from VF-92 scored the first kill of 10 May after blasting their F-4s down the Kep runway near Hanoi to stir up the MiGs.

TWO MiGs IN ONE DAY: RIO Lt Thomas Blonski of UF-96 'Fighting Falcons' aboard the *Constellation* looks on as his pilot, Lt Matt Connelly, relives one of their duels with MiGs on 10 May. Two MiGs fell to their AIM-9 Sidewinders that day.

THE FOE: North Vietnamese MiG-17s shelter behind bunkers between missions. Although the faster MiG-21 was available, many experienced pilots, such as Colonel Tomb, favoured the nimble 'Fresco' for combat.

MCDONNELL DOUGLAS HELICOPTERS

AH-64 APACHE

● Armoured gunship ● Tank destroyer ● Infantry close-support

Equipped with video-type electronic aiming devices, Hellfire missiles and rapid-fire cannon, the AH-64 Apache is a new kind of warrior bringing a powerful punch to the battlefield. When a ground commander wants support he summons the Apache, a miracle helicopter which can rush into the fray in any weather, day or night, to pin down the foe and help friendly troops to fight and win.

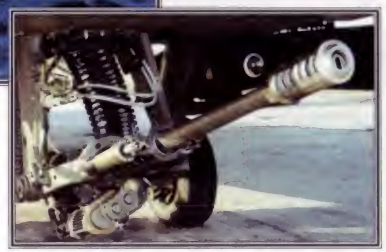
▲ *Designed to fly and fight in the hostile airspace over a modern battlefield, the AH-64 is a potent weapons platform.*

PHOTO FILE

MCDONNELL DOUGLAS HELICOPTERS AH-64 APACHE

Tank killer ▶
The Apache's primary weapon is the laser-guided Hellfire missile. It can destroy any known tank.

Combat reliability ▶
Apaches are complex machines, but they are designed to be serviced easily in the field.



▲ All-weather attacker
Fast, agile and very tough, the AH-64 uses its advanced sensors to fly and fight in all conditions.

▼ Into action
The Apache was one of the stars in the Gulf War, its hi-tech weaponry proving lethal to a wide range of Iraqi targets.

▲ Chain Gun
The helicopter's powerful 30-mm (1.18-in) cannon is linked to the crew's helmets, aiming where the pilot or gunner is looking.

◀ See through fog
The Longbow Apache is equipped with millimetric radar which is capable of seeing through rain, fog and snow.

FACTS AND FIGURES

- The Apache is designed to survive hits from 23-mm (0.91-in) cannon, and the cockpit to withstand hitting the ground at 13 m (42 ft 8 in) per second.
- The Apache uses a super-heated ceramic block to deceive heat-seeking missiles.
- Apache operators include Egypt, Greece, Israel, Saudi Arabia, the UAE and the USA.
- The Apache's 16 laser-guided Hellfire missiles can destroy a tank 20 km (12 miles) away.
- The Apache uses digital technology to pinpoint targets for commanders, other helicopters, tanks and vehicles.
- The Apache's Chain Gun weighs 56 kg (123 lb) and fires 625 rounds per minute.

PROFILE

Battlefield destroyer

It is important, when a battle is unfolding, to hit hard and disrupt the enemy's forces. The helicopter represents the new knight in shining armour to ground troops, who need the flexibility and striking power of their own aircraft overhead, and the AH-64 Apache is the undisputed champion of battlefield helicopters.

The Apache uses electronic wizardry to find its way and to aim its hi-tech missiles and cannon. The two pilots of the slender, mantis-like Apache can hug the earth when they need to, or navigate through smoke and rough weather to seek out enemy troops and tanks using night-vision equipment and hi-tech sensors.

Assisted by observation helicopters and staying in close contact with troops on the ground, the Apache is able to shoot with remarkable accuracy from a greater distance than most other combat helicopters.

In high-threat environments Apaches operate at low level, usually attacking from among the trees.

With its combination of speed, durability and accuracy, the Apache brings a new dimension to the ground commander's task of outsmarting and outfighting his adversary.

AH-64A Apache

Israel's Defence Force was the first organization to acquire the Apache after the US Army.

The Israelis have a wealth of combat experience with gunships, and consider the AH-64 the best of its kind. It has the standard gunship layout of gunner in front and pilot behind.

Passive Night Vision (PNV) sensors in the nose include infra-red and TV cameras and a laser designation system.

The engines are fitted with 'Black Hole' infra-red suppression systems as protection against heat-seeking missiles.

The two-tail rotor blades cross at 55°, which reduces the amount of noise they generate.

Apaches carry up to 1,200 rounds of 30-mm ammunition for the Chain Gun. It can fire at up to 625 rounds per minute.

Stub wings carry up to 16 missiles or four pods containing 76 folding-fin 70-mm high-explosive rockets.

The structure of the AH-64 is designed to allow it to withstand hits from high-explosive rounds of up to 23-mm (0.91-in) calibre.

Communications and avionics systems are carried in armoured fairings on each side of the fuselage.

Power is provided by a pair of 1265-kW (1,696-hp) General Electric engines. Key propulsion components are armour-protected.

The four-bladed main rotor is of laminated steel, glass-reinforced plastic and composite construction.

AH-64A Apache

Type: two-seat all-weather attack helicopter

Powerplant: two 1265-kW (1,696-hp) General Electric T700-GE-701 turboshaft engines

Maximum speed: never-exceed speed 365 km/h (227 mph); maximum cruise speed 297 km/h (185 mph)

Initial climb rate: 760 m/min (2500 ft/min)

Weights: empty 5165 kg (11,387 lb); normal mission weight 8000 kg (17,637 lb); maximum take-off 9525 kg (21,000 lb); maximum internal fuel weight 1157 kg (2,551 lb)

Armament: one 30-mm (1.18-in) M230 Chain Gun cannon with 1200 rounds, up to 16 AGM-114 Hellfire laser-guided missiles or up to 76 folding-fin rockets

Dimensions:

rotor diameter	19.55 m (64 ft 2 in)
fuselage length	14.97 m (49 ft 1 in)
height to top of rotor head	4.66 m (15 ft 3 in)
rotor area	168.11 m² (1,810 sq ft)

COMBAT DATA

HOVER CEILING

Both the Apache and the Havoc have more power than the Tiger, and can hover a kilometre higher than the Franco-German machine. This is not the absolute ceiling: sometimes the terrain and air temperature bounce the air from the rotors straight back up in what is called ground effect, and the extra air cushion can add one or two thousand metres to the hover limits.

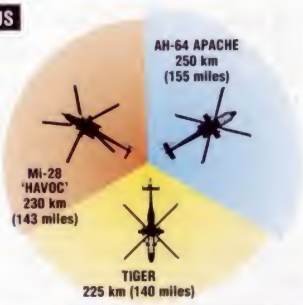
MAXIMUM SPEED

All three helicopters have a good turn of speed, with the Mi-28 having a very slight edge.

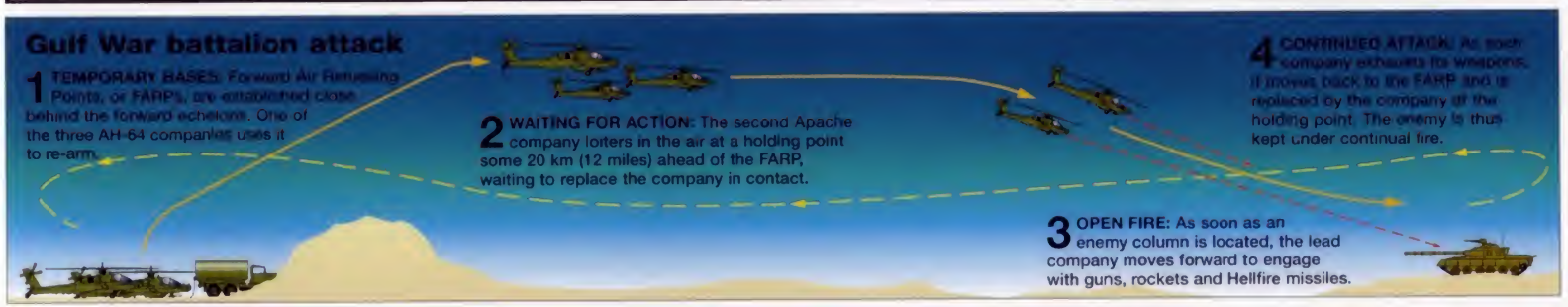
Mi-28 'HAVOC'	300 km/h (186 mph)
AH-64 APACHE	297 km/h (185 mph)
TIGER	280 km/h (174 mph)

COMBAT RADIUS

As attack helicopters operate from forward bases close to the fighting, they do not need long range. Fighting at close quarters means that being able to refuel and re-arm quickly is more important than being able to fly great distances.



Gulf War battalion attack



1 TEMPORARY BASES: Forward Air Refueling Points, or FARPs, are established close behind the forward echelons. One of the three AH-64 companies uses it to re-arm.

2 WAITING FOR ACTION: The second Apache company loiters in the air at a holding point some 20 km (12 miles) ahead of the FARP, waiting to replace the company in contact.

3 OPEN FIRE: As soon as an enemy column is located, the lead company moves forward to engage with guns, rockets and Hellfire missiles.

4 CONTINUED ATTACK: As each company exhausts its weapons, it moves back to the FARP and is replaced by the company at the holding point. The enemy is thus kept under continual fire.

MIKOYAN-GUREVICH

MiG-15 'FAGOT'

● Swept-wing fighter ● Korean War warrior ● Sabre's foe

▲ *Crude and simple it may have been, but in many ways the MiG-15 was the best fighter in the world when it first flew in the late 1940s. In the hands of experienced Soviet pilots, it was a real threat to the West.*

In the history of war, few events have been as shocking as the surprise debut of the MiG-15 in Korea. Unprepared, the United States saw its aircraft suffer defeat after defeat until the F-86 Sabre was thrown into the fray. The duel between Sabre and MiG-15 became a classic military campaign. Although superior in some ways, the MiG-15 ultimately suffered a seven-to-one defeat by American Sabre pilots.

PHOTO FILE

MIKOYAN-GUREVICH MiG-15 'FAGOT'

▲ Combat trainer
Due to the success of the MiG-15UTI, China built a derivative based mainly on the MiG-17. Called the Chengdu JJ-5, more than 1000 have been produced, including this example flown by the Bangladesh air force.

▲ Swept-wing pioneer
The MiG-15 was designed using German research (captured by the USSR in 1945) into swept wings, and was one of the first operational jets of this type.

▲ Founder of a family
A Polish MiG-15, flanked here by two MiG-17s, is distinguishable by its lack of an afterburning tailpipe. The MiG-17 was a more powerful evolution of the basic design, which retained all the earlier jet's agility and fighting ability. The two-seat MiG-15UTI was used as a basic trainer by many Warsaw Pact nations.

▲ Cold War defender
The MiG-15 formed the backbone of Soviet and Warsaw Pact air forces for most of the 1950s.

Middle East survivor ▶
Egypt has long been a MiG user. Surviving two-seat MiG-15UTIs have been upgraded with Western avionics.

FACTS AND FIGURES

- The MiG-15 was initially given the NATO codename 'Falcon'. It was thought too favourable, and was changed to 'Fagot'.
- The first flight took place on 30 December 1947, three months after the XP-86 Sabre.
- Early MiG-15s had RD-45F engines; improved versions had the VK-1 engine.
- When the Korean War began, 1,200 MiG-15s were flying; Britain had only two aircraft with swept wings.
- The Allies in Korea offered $100,000 to any pilot who would defect in a MiG-15.
- Several MiG-15s now fly as 'warbirds' in private hands in the USA and the UK.

PROFILE

The first Cold War superfighter

The MiG-15, which first flew weeks after the F-86 Sabre, proved that the Soviet Union could design, produce and use a jet fighter as modern as any in the world. The MiG-15 had better climb, ceiling, rate of roll and turn radius than early F-86s, and only with late versions of the F-86F, introduced in 1953, did the Soviet fighter inescapably meet its superior. The Sabre's success against the MiG was due less to the aircraft than to the skill and tactics of American pilots.

Still, the MiG-15 was a triumph – the word MiG itself is recognized by more humans than any other aircraft name. The Mikoyan-Gurevich bureau's best-known product became one of the most numerous warplanes in the second half of the twentieth century, operated by dozens of countries.

Although no two-seat version of its arch-rival, the Sabre, succeeded, more than 1000 MiG-15UTI two-seaters have trained pilots the world over, and a small number remain in service with Third World nations.

The US Air Force acquired a MiG-15 during the Korean War, and tested it very thoroughly. Famed test pilot Chuck Yeager was impressed by the rugged Soviet-built jet.

MiG-15UTI 'Midget'

Type: two-seat advanced pilot and weapons trainer

Powerplant: one 26.48-kN (5,956-lb-thrust) VK-1 centrifugal-flow turbojet (derived from Rolls-Royce Nene)

Maximum speed: 1073 km/h (667 mph) at sea level

Range: 1424 km (885 miles)

Service ceiling: 15,600 m (51,181 ft)

Weights: empty 4000 kg (8,818 lb); loaded 5400 kg (11,905 lb)

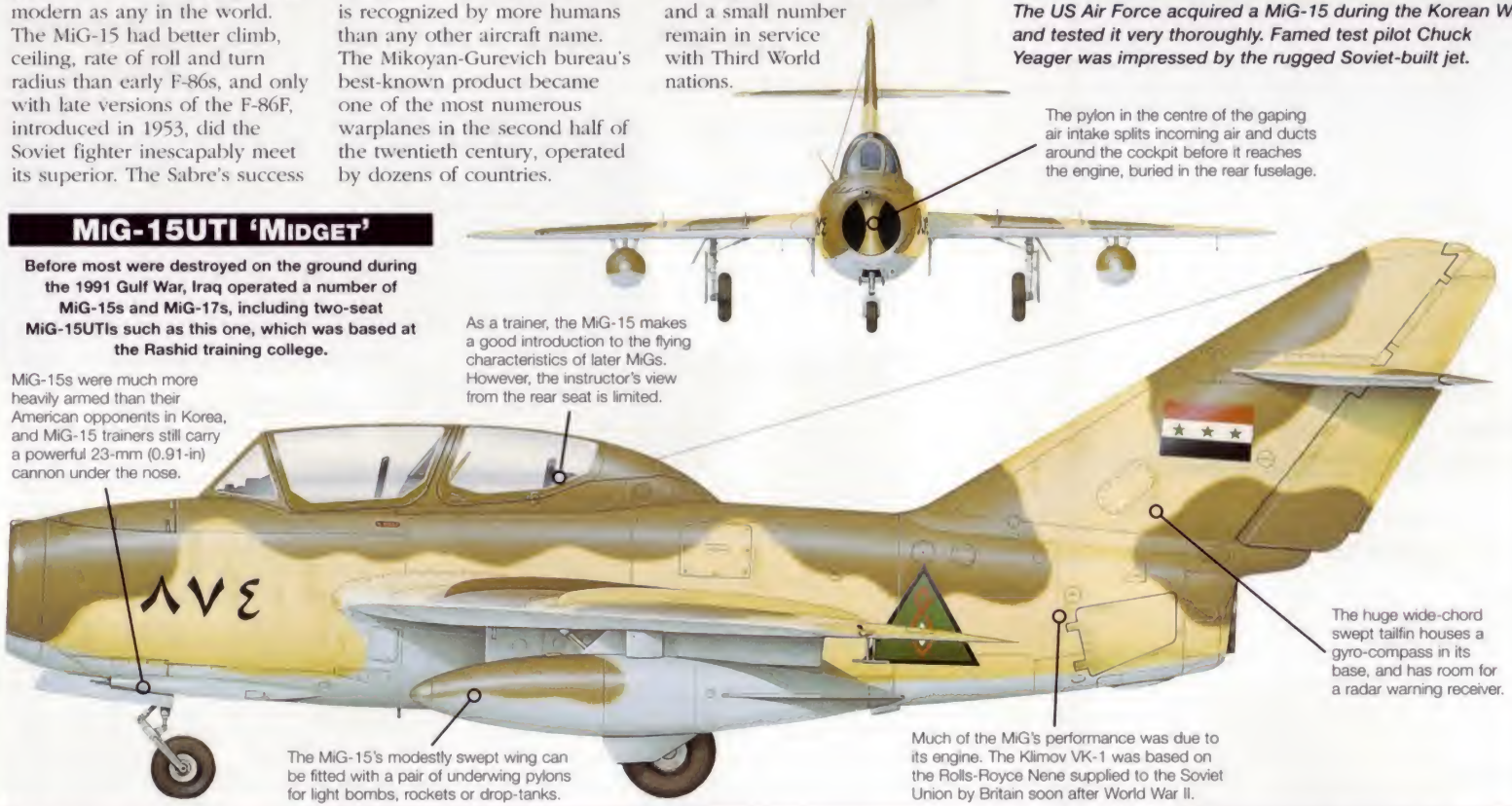
Armament: often not fitted, or one 23-mm (0.91-in) cannon with 80 rounds or one 12.7-mm (0.5-in) cannon with 150 rounds, plus option of two 500-kg (1,100-lb) bombs carried underwing as an alternative to drop-tanks

Dimensions:

span	10.08 m (33 ft 1 in)
length	10.04 m (33 ft)
height	3.74 m (12 ft 3 in)
wing area	20.60 m² (222 sq ft)

MiG-15UTI 'Midget'

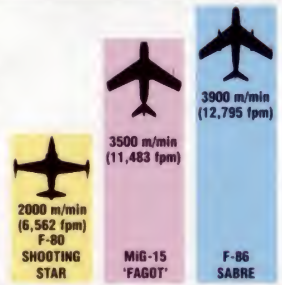
Before most were destroyed on the ground during the 1991 Gulf War, Iraq operated a number of MiG-15s and MiG-17s, including two-seat MiG-15UTIs such as this one, which was based at the Rashid training college.



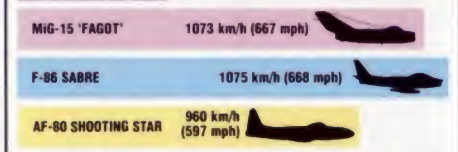
COMBAT DATA

CLIMB RATE

The F-86 was more powerful than the MiG, and from sea level was initially a faster-climbing machine. But it was also heavier, and at higher altitudes the Soviet-built jet had a considerable advantage. The F-80 was one of the first generation of jet fighters and lacked the performance of its swept-wing rivals.



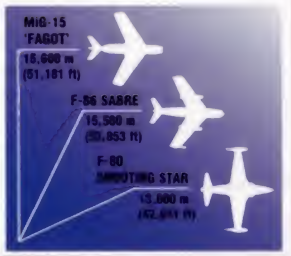
MAXIMUM SPEED



Both the MiG and its great rival the Sabre were greatly superior to the previous generation of jets. The Sabre was marginally faster at high altitude, but the MiG probably handled a little better.

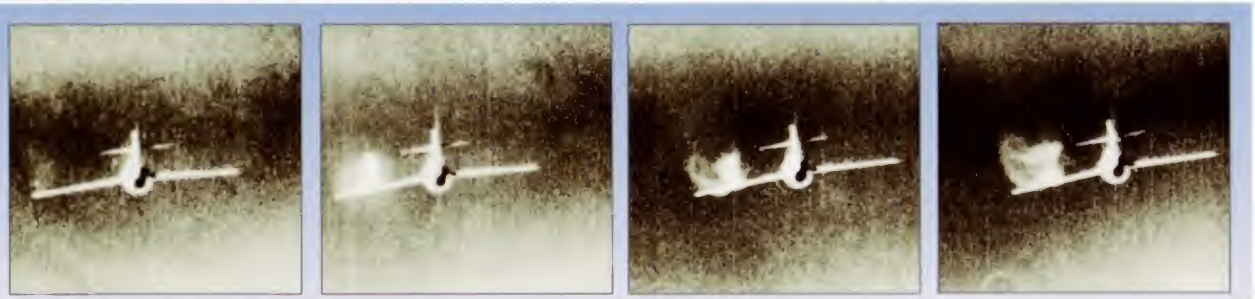
SERVICE CEILING

Once again, the MiG and the Sabre proved to be considerably more capable than the earlier generation of jets. The MiG's high ceiling was of particular value in the early days of the Korean War, when they often used it to climb high above American B-29 bombers and their fighter escorts.



MiG shootdown!

The MiG had a better climb rate and acceleration and was more manoeuvrable at high altitude than its American opponent in Korea, the Sabre. But any advantage the Communists had was negated by the better-trained American pilots: in two years of fierce fighting, 780 MiG-15s were downed for the loss of 110 Sabres. In the last six months of the war F-86s achieved a kill ratio of nearly nine to one.



MIKOYAN-GUREVICH

MiG-17 'FRESCO'

● MiG-15 successor ● Interceptor/ground attack ● Huge production

In January 1950, barely a year after the MiG-15 had entered service, Mikoyan flew the first prototype of its successor. The new fighter, designated MiG-17 and named 'Fresco' by NATO, was to be one of the most widely exported of all Soviet military aircraft. More than 9000 were built, including approximately 900 produced in Poland as the LIM-5 and LIM-6. Several of the world's smaller air forces were still flying the type in the early 1990s.

▲ *Pilots were pleased that the high-speed stability and control problems of the MiG-15 had been solved in the MiG-17.*

PHOTO FILE

MIKOYAN-GUREVICH MiG-17 'FRESCO'

▼ Afterburning night-fighter
East Germany operated the radar-equipped, afterburning MiG-17PF 'Fresco-D' all-weather/night fighter.

▲ Afterburning variant
The MiG-17F 'Fresco-C', which introduced the afterburning VK-1F engine, quickly replaced the MiG-17 'Fresco' in service. It formed the basis of most export aircraft and Chinese and Polish production.

▲ MiG-17SN experimental
The side-mounted intakes of the SN allowed the whole nose section to be occupied by a rotating cannon assembly.

▼ Syrian defector
Two MiG-17Fs fell into Israeli hands when their Syrian pilots defected. They were extensively tested by the Israeli air force.

▲ Radar scanner and cannon
Using an installation similar to that of the MiG-15, the MiG-17PF's upper intake-lip radome housed an RP-1 Izumrud radar scanner. A third NR-23 cannon was installed in place of the N-37D and the fuselage was slightly lengthened.

FACTS AND FIGURES

- The first MiG-17, which was also known as the MiG-17, SI, I-330 or MiG-15bis-45°, flew on 13 January 1950.
- On 20 March 1950 the second MiG-17 prototype crashed.
- Flight testing of an afterburner-equipped MiG-17 began on 29 September 1951.
- More than 1700 MiG-17s have been exported, not including licensed production.
- Poland retired its last licence-built MiG-17s in 1991/92.
- A number of 'Frescos' are flown by a secret squadron of the USAF.

PROFILE

Multi-faceted 'Fresco'

Developed to improve on the MiG-15's handling, especially at high speeds, the MiG-17 featured a thinner, more swept wing, longer fuselage and a bigger tail. Deliveries started in 1952, and by 1953 almost all MiG-15 production lines had switched to the new design. The MiG-17P, with radar scanners in the nose and a slightly longer fuselage to make room for the additional equipment, was an interceptor version of the basic MiG-17.

The MiG-17F introduced an afterburning engine, and the PF was an afterburner-equipped counterpart of the MiG-17P. Until this point all MiG-17s had been armed with guns, but the PFU carried four AA-1 'Alkali' air-to-air missiles instead. This entered service in the late 1950s.

As newer fighters appeared, many MiG-17s switched to ground attack. The Polish-built LIM-5M used rockets to shorten its take-off run with an increased bombload, and a braking parachute to shorten landing distances. MiG-17Fs were also produced in China as Shenyang J-5s. Aircraft built for export were designated F-5 and FT-5.

This Soviet MiG-17F has the twin 600-litre (159-US gal) drop-tanks, a near-standard feature.

Hardest hitting of the 'Fresco-C's' weapons was the 37-mm (1.46-in) cannon mounted in a fairing on the lower starboard nose. The MiG-17P, PF and SP-2 MiG-17 all had variations of the standard armament.

Compared to the MiG-15, the 'Fresco' had one extra wing fence on each wing. The inner fence was moved inboard and the new fence was fitted outboard of the ailerons.

MiG-17F 'Fresco-C'

Type: single-seat fighter

Powerplant: one 33.2-kN (7,467-lb-thrust) Klimov VK-1F afterburning turbojet

Maximum speed: 1100 km/h (684 mph) at 3000 m (9,843 ft)

Initial climb rate: 3900 m/min (12,795 fpm)

Combat radius: 700 km (435 miles) on a hi-lo-hi mission with two 250-kg (550-lb) bombs

Service ceiling: 16,600 m (54,462 ft)

Weights: empty 3930 kg (8,664 lb); maximum take-off 6069 kg (13,380 lb)

Armament: two 23-mm (0.91-in) NR-23 and one 37-mm (1.46-in) N-37D cannon, plus 500 kg (1,100 lb) of bombs

Dimensions:

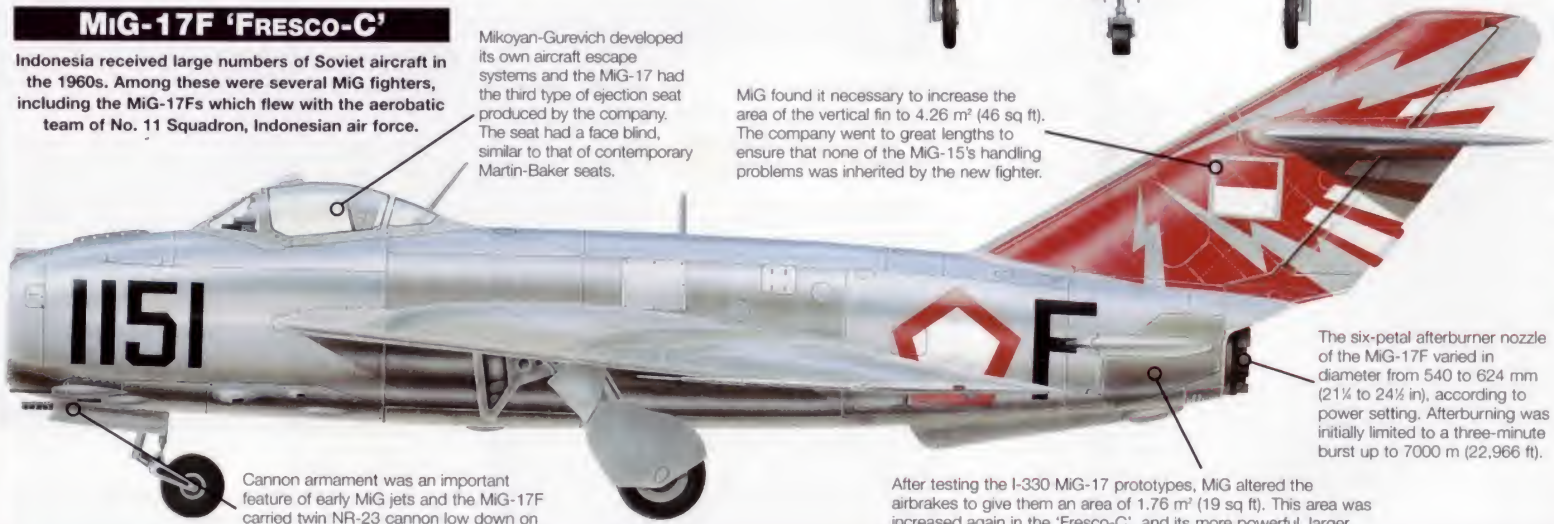
span	9.63 m (31 ft 7 in)
length	11.26 m (36 ft 11 in)
height	3.80 m (12 ft 6 in)
wing area	22.60 m² (243 sq ft)

MiG-17F 'Fresco-C'

Indonesia received large numbers of Soviet aircraft in the 1960s. Among these were several MiG fighters, including the MiG-17Fs which flew with the aerobatic team of No. 11 Squadron, Indonesian air force.

Mikoyan-Gurevich developed its own aircraft escape systems and the MiG-17 had the third type of ejection seat produced by the company. The seat had a face blind, similar to that of contemporary Martin-Baker seats.

MiG found it necessary to increase the area of the vertical fin to 4.26 m² (46 sq ft). The company went to great lengths to ensure that none of the MiG-15's handling problems was inherited by the new fighter.



The six-petal afterburner nozzle of the MiG-17F varied in diameter from 540 to 624 mm (21¼ to 24½ in), according to power setting. Afterburning was initially limited to a three-minute burst up to 7000 m (22,966 ft).

Cannon armament was an important feature of early MiG jets and the MiG-17F carried twin NR-23 cannon low down on the port forward fuselage.

After testing the I-330 MiG-17 prototypes, MiG altered the airbrakes to give them an area of 1.76 m² (19 sq ft). This area was increased again in the 'Fresco-C', and its more powerful, larger airbrake actuator rams were covered by distinctive blister fairings.

COMBAT DATA

THRUST

Even with afterburning the 'Fresco-C' had less thrust than the non-afterburning Hunter F.Mk 6 and F-86H Sabre. The Hunter did not, however, have the development potential of the Soviet aircraft.

SERVICE CEILING

Both the Hunter and Sabre represented developments of older designs, and neither could equal the altitude performance of the MiG-17F. The MiG was to remain in widespread service as an effective combat aircraft long after its Western rivals.

MiG fighter development

MIG-15 'FAGOT': Known also as the I-310, the MiG-15 came as a shock to the West when it was encountered over Korea in 1950. It was the world's first successful swept-wing fighter.

I-320: Designed in response to a 1948 requirement for a long-range radar-equipped fighter, the I-320 was a twin-engined development of the MiG-15. Three were built.

SN: A development of the MiG-17, the SN had guns installed in the nose that pivoted in the vertical plane. Side-mounted intakes were fitted. Performance was shown to suffer during trials.

I-350: A supersonic, radar-equipped derivative of the MiG-17, the I-350 used a single, untested engine design. The unreliability of this powerplant led to the aircraft's cancellation.

MiG-19 'FARMER': The Soviet air force's first supersonic fighter, the twin-engined MiG-19 was the last swept-wing MiG design before the delta-wing MiG-21. Large numbers were built.

MIKOYAN-GUREVICH

MiG-19 'FARMER'

● 1960s dogfighter ● Indo-Pak War veteran ● Supersonic interceptor

▲ *The MiG-19 showed that Soviet aviation remained as advanced as that of the USA during the 1950s, taking fighter aircraft through the sound barrier with a design that still remains in service.*

Entering service in 1955, the MiG-19 'Farmer' was Russia's first supersonic fighter. More than four decades later, this sleek Mikoyan-Gurevich aircraft remains a formidable opponent in a dogfight. The 'Farmer' has the traditional MiG agility and its cannon produce enormous firepower. Although quickly replaced in the Soviet Union, derivatives of the MiG-19 have found remarkable success in China, which has exported it to many countries.

PHOTO FILE

MIKOYAN-GUREVICH MiG-19 'FARMER'

▼ Gunfighter
The MiG-19's powerful armament of three 30-mm (1.18-in) cannon outranged most of its opponents.

▲ Radar gunsight
Later MiG-19s, such as this 'M' version, had primitive ranging radar and also carried four simple 'beam-riding' air-to-air missiles.

▲ Wing fence
The large blade on top of the wing is called a 'fence' and is designed to reduce drag.

▼ Pakistan's finest
Pakistan uses the Chinese-built Shenyang F-6, a greatly improved copy of the MiG-19.

▲ Dogfight victim
This Chinese-built MiG-19 of the Pakistan air force is caught in a dogfight with an F-16. The MiG-19 cannot hold its own against modern fighters.

FACTS AND FIGURES

- About 2700 MiG-19s were manufactured, compared with 2294 examples of the contemporary American Super Sabre.
- Small numbers of Chinese-supplied MiG-19s fought in the Vietnam War.
- A few Soviet 'Farmers' had a 'Scan Odd' gun-ranging radar in the upper nose.
- A MiG-19 prototype, the I-350, may have beaten the North American F-100 past the sound barrier.
- The aircraft also served in Poland, Bulgaria, East Germany and Romania.
- The Chinese Shenyang F-6 version made its first flight in December 1961.

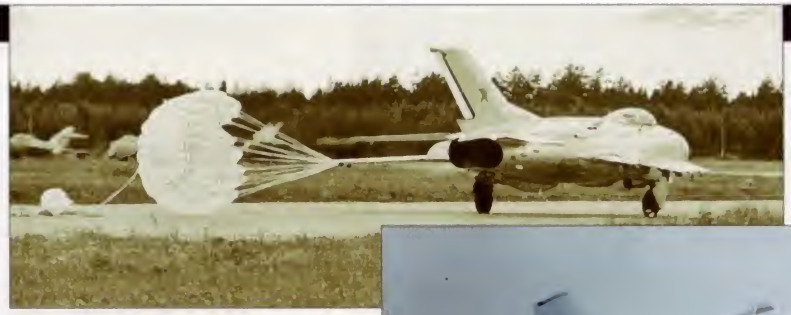
PROFILE

MiG goes supersonic

The Mikoyan-Gurevich design bureau confirmed its place in the front ranks of world aircraft design with its very impressive twin-engined MiG-19. The North American F-100 Super Sabre, flown on 25 May 1953, is traditionally regarded as the first fighter capable of supersonic speed in level flight; however, the production MiG-19, which took to the air the following year, was never far behind. And at Mach 1.33, it was much faster than its American counterpart.

The MiG-19 'Farmer' was not built in as large numbers as the earlier MiG-17 and later MiG-21, and production was transferred to Czechoslovakia in 1958. In the same year China began to build its version, the Shenyang F-6.

MiG-19s served Soviet Frontal Aviation squadrons through the 1960s, with later versions receiving radar and guided missiles. The Chinese-built F-6 became the backbone of the PLA air force, and this version was still in production as recently as 1990. It has been exported widely in the Third World, uprated with new ejection seats, avionics and Sidewinder missiles.



Above: The higher landing speeds of aircraft such as the MiG-19 made brakechutes a standard feature on fighters in the mid-1960s. Initially dismissed as inferior by American observers, the MiG-19 'Farmer' was later reappraised.

Above: Czechoslovakia produced large numbers of MiG-19s, designated the S-105. The aircraft's large ventral airbrake can clearly be seen in this picture.

MiG-19SF 'Farmer-C'

Type: single-seat day fighter-bomber

Powerplant: two 32.66-kN (7,346-lb-thrust) MNPK 'Soyuz' (Tumansky) RD-9BM afterburning turbojets

Maximum speed: 1452 km/h (902 mph) at high altitude

Ferry range: 2200 km (1,367 miles)

Service ceiling: 18,500 m (60,695 ft)

Weights: empty 5760 kg (12,700 lb); maximum take-off 9100 kg (20,062 lb)

Armament: two or three 30-mm (1.18-in) NR-30 cannon each with 73 rounds; provision for two bombs of up to 454 kg (1,000 lb) (usually 227-kg/500-lb) bombs carried), various single or multi-barrel pod rockets, two 767-litre (203-US gal) fuel tanks or four missiles

Dimensions:

span	9.20 m (30 ft 2 in)
length	12.60 m (41 ft 4 in)
height	3.88 m (12 ft 9 in)
wing area	25.00 m² (269 sq ft)

MiG-19S 'FARMER'

This carmine-red and blue-grey aircraft was part of a special aerobatic display team organized in the VVS Moscow Military District from 1958 until 1966.

The cockpit has relatively cluttered forward visibility due to the large gunsight. The ejection seat cannot be used safely at low airspeeds.

The MiG-19 has a highly swept wing in order to attain its supersonic speed. Four pylons on the wings could carry the K5M 'Alkali' missile. Pakistan's Shenyang J-6s carry the more effective American AIM-9P Sidewinder.

Like the MiG-15 and MiG-17, the MiG-19 had prominent wing fences to reduce induced drag. The MiG-19PM had no cannon but carried four underwing missiles.

The improved MiG-19S featured an all-moving tailplane as well as other refinements to the flying controls. The distinctive kink in the fin leading edge is a useful recognition feature to distinguish the MiG-19 from the similar MiG-17.

The first MiG-19s had three 23-mm NR-23 cannon, but these were upgraded to NR-30s in later production aircraft. The 30-mm gun caused devastating damage but had a short range and slow rate of fire.

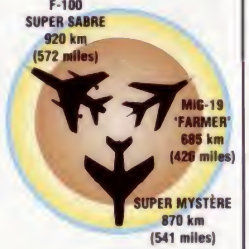
Air was fed through a nose intake containing a splitter plate that separated the airflow to each engine. The air passed through the airframe in two tunnels under the cockpit, then to the engines.

The MiG-19PF had more powerful Mikulin engines and later versions used Tumansky RD-9B turbojets. The Wopen engine of the Chinese-built versions is almost identical.

COMBAT DATA

COMBAT RADIUS

Soviet designers have traditionally given their aircraft greater performance at the expense of range, by cutting fuel capacity. The low cost of MiGs compared to Western fighters meant that their short range could be compensated for by building more aircraft and bases around the edge of the Soviet Union. The latest MiG-29 was designed with the same tactical philosophy as the old MiG-19.

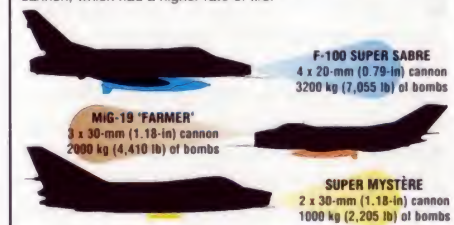


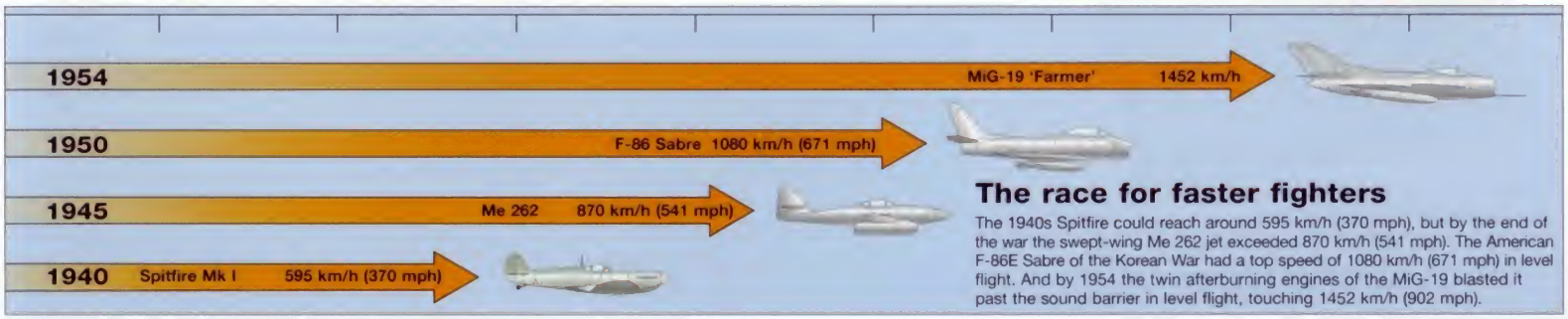
MAXIMUM SPEED

The MiG-19 could outrun any fighter of its day with reheat selected, easily faster than the Super Mystère or F-100.

WEAPONS

Since the 1930s heavy cannon were a favoured feature of Russian designers. The three 23-mm (0.91-in) cannon of early MiG-19s were replaced by even harder hitting 30-mm (1.18-in) NR-30 cannon, which had a higher rate of fire.





The race for faster fighters

The 1940s Spitfire could reach around 595 km/h (370 mph), but by the end of the war the swept-wing Me 262 jet exceeded 870 km/h (541 mph). The American F-86E Sabre of the Korean War had a top speed of 1080 km/h (671 mph) in level flight. And by 1954 the twin afterburning engines of the MiG-19 blasted it past the sound barrier in level flight, touching 1452 km/h (902 mph).

MIKOYAN-GUREVICH

MiG-21 'FISHBED' (EARLY)

● First generation ● Outstanding performance ● Record-breaker

In the early 1950s, a small number of MiG design bureau members began to study a concept for an interceptor capable of reaching speeds of 2000 km/h (1,243 mph). Two designs of swept- and delta-wing configuration were chosen, known as Ye-2 and Ye-4, respectively. The delta-wing model was selected for production and this became the MiG-21F, which entered service with the VVS (Soviet air force) in 1959.

▲ *First-generation MiG-21s were somewhat limited as frontline interceptors, yet they were superb aerial performers. More importantly, they became the most numerous jet fighter.*

PHOTO FILE

MIKOYAN-GUREVICH MiG-21 'FISHBED' (EARLY)

◀ Vapour trails
An early MiG-21F-13 is seen during a climb. The smoke trailing from the wings appears to be caused by vortices but is, in fact, coming from the twin ARS-57 rocket-launchers which were fitted beneath the wings.

▼ Quickest and cleanest
Early MiG-21s had very clean lines, making them lithe-looking aircraft compared to their successors.

▲ Czech 'Fishbeds'
Czechoslovakia was one of the first countries to acquire a licence to build MiG-21s. Known as CS-106s, these lacked the transparent panels behind the cockpit canopy.

▼ Stopping aid
Despite being a very light aircraft, the MiG-21 still required a braking parachute to slow it down upon landing.

▲ Design limitations
Compared to Western fighters of the period, the MiG-21 was small, sleek and simple. This resulted in limited avionics and armament, and the early variants were barely acceptable as frontline fighters.

FACTS AND FIGURES

- With more than 10,000 built and service with 56 different air forces, the MiG-21 is the most widely built jet fighter.
- In 1961 a prototype, the Ye-6/3, set a world height record of 34,714 m (113,891 ft).
- A MiG-21F-13 was the first 'Fishbed' to be acquired by the USAF for evaluation.
- The exhilarating performance of the early variants led to one Indian pilot dubbing his as 'my supersonic sports car'.
- Chengdu F-7s are basically new-build first-generation MiG-21s.
- Western analysts first thought that the MiG-21 was the swept-wing Ye-2.

PROFILE

Supersonic interceptors

Small and narrow, with a tiny wing area, the MiG-21 was conceived as a short-range point defence interceptor, based on experience gained in the Korean War.

The origins of this fighter can be traced to two distinct families: the Ye-2 swept-wing proposal and the delta-wing Ye-4. Tests proved that the Ye-4 offered slight advantages in performance, fuel capacity and agility, thus it was chosen over its swept-wing rival. An improved derivative was designated the Ye-6T and this became the series production MiG-21F-13. These early aircraft entered widespread service from 1960 onwards. A very basic radar and armament fit were incorporated, but, right from the beginning, these early aircraft were destined to be interim machines, pending availability of more advanced MiG-21 variants.

This new supersonic jet, code-named 'Fishbed' by NATO, was utilized not only by the Soviet Union, but also by other nations such as Czechoslovakia (which acquired a licence to build it), and many other countries around the world. The basic design was also built in China without a licence and formed the basis of the Chengdu F-7 Airguard which is in widespread use today.

Above: Indonesia was one of the more unusual operators of the MiG-21. This early F model is now preserved at a museum in Jakarta.

Below: Among the last of the first-generation models in frontline service were those of the Finnish Ilmavoimat, which were finally retired in 1986.

MiG-21F-13 'Fishbed-C'

Type: single-seat air superiority fighter

Powerplant: one 60.58-kN (!3,625-lb-thrust) Tumanskii R-11F-300 twin-spool afterburning turbojet

Maximum speed: 2175 km/h (1,351 mph)

Endurance: 2 hrs 30 mins

Range: 1420 km (882 miles)

Service ceiling: 19,000 m (62,336 ft)

Weights: empty 4871 kg (10,739 lb); loaded 8625 kg (19,015 lb)

Armament: one 30-mm (1.18-in) NR-30 cannon, later replaced by a gun pack housing a GSh-23L or GP-9 twin-barrel cannon and two K-13A (AA-2 'Atoll') air-to air missiles

Dimensions:

span	7.15 m (23 ft 5 in)
length	15.76 m (51 ft 8 in)
height	4.10 m (13 ft 5 in)
wing area	23.00 m² (248 sq ft)

MiG-21F-13 'Fishbed-C'

Romania received a batch of late-model MiG-21F-13s, including '902' shown here. As Romania had somewhat looser ties with the former Soviet Union, this resulted in Romanian 'Fishbeds' being a comparatively late delivery.

Despite its poor range, basic avionics suite and light armament, the MiG-21F was without doubt a true pilot's aircraft. Hydraulic controls and light weight made it an ideal aerobatic platform. By Western standards, the ergonomic layout of the cockpit was appalling, with the controls scattered and the interior tight and cramped.

Early Soviet machines had twin transparent panels mounted on either side behind the cockpit. These did little to improve visibility and were deleted, first from Czech-built MiG-21Fs, and then from all subsequent aircraft (such as this example).

A very small and crude ranging radar was housed inside the bullet fairing in the intake duct. This was linked to a rudimentary gunsight. The undernose pitot boom was a characteristic of the early variants.

With range severely limited, extra fuel was essential for combat sorties. A single centreline drop tank was often carried.

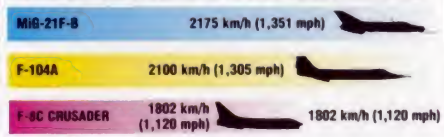
MiG-21Fs were often seen carrying a pair of K-13A short-range air-to-air missiles. These were essentially copies of the early AIM-9 Sidewinders used on Western aircraft.

Propulsion was by means of a single Tumanskii R-11 twin-spool turbojet. Full afterburner was seldom used as it seriously restricted the aeroplane's endurance to a matter of minutes.

COMBAT DATA

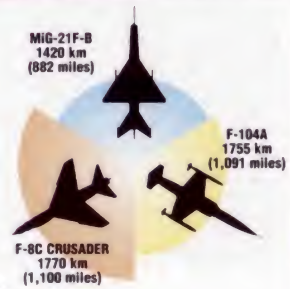
MAXIMUM SPEED

Lithe and little, the early MiG-21s were the fastest of all variants and quicker than rival Western designs, such as the Lockheed F-104 Starfighter which was designed to a similar specification. The Crusader was slower, but was a better equipped combat jet.



RANGE

Both MiG-21Fs and early Starfighters were notorious for their very poor range. Afterburner had to be used sparingly to extend endurance as much as possible. Navy aircraft such as the F-8 had to operate over greater distances and consequently had greater range.



SERVICE CEILING

These early supersonic fighters were little more than manned missiles with wings and could reach altitudes previously unheard of. Early MiG-21s could reach almost 20,000 m (65,620 ft) and indeed one of the prototypes set the world height record in 1961. The Crusader, surprisingly, had a greater service ceiling than the F-104.

Early MiG-21s in service

MiG-21F-13, PEOPLE'S REPUBLIC OF CHINA: In the late 1950s, China and the Soviet Union shed ties. Production of the aircraft was begun in China under the designation J-7. These aircraft served alongside a handful of genuine MiG-21Fs.

MiG-21FL INDIAN AIR FORCE: India was another country which built MiG-21s under licence, though these were all second-generation machines, known as Type-77 in the Indian inventory. These are still in service today and have been upgraded.

MiG-21PF-31 AFGHAN REPUBLICAN AIR FORCE: Second-generation MiG-21PFs were also supplied to Afghanistan during the late 1960s and early 1970s. Since the Islamic revolution not much is known about their fate, although a few may still exist.

MIKOYAN-GUREVICH

MiG-21 'FISHBED' (SECOND GENERATION)

● Supersonic interceptor ● More built than any other jet fighter

A top-notch dogfighter, the MiG-21 has the flying properties demanded by pilots. It is light, nimble, fast, and armed to the teeth. Other fighters may have longer range, but the MiG-21 is the nasty triggerman of the skies, primed to strike and kill. Used by many nations and in many conflicts, this flying 'hot rod' deserves to be called the most successful jet fighter ever built.

▲ *Wearing pressure suits, these intrepid Soviet pilots prepare for a mission in their MiG-21s. In a zoom climb, the MiG could reach an altitude of more than 20,000 m (65,617 ft).*

PHOTO FILE

MIKOYAN-GUREVICH MiG-21 'FISHBED' (SECOND GENERATION)

◀ Reconnaissance fighter
MiG-21Rs, such as this Czech aircraft, carried a belly pod crammed with cameras and electronic sensors, together with extra avionics in the bulged dorsal spine.

▲ Steam-age cockpit
Unlike today's fighters, the MiG-21 had a cockpit jam-packed with dials and switches. Pilots loved it nonetheless.

Trainer ▶
The two-seat MiG-21U and the upgraded MiG-21US and UM were given the NATO code name 'Mongol'. They are mainly used for conversion and continuation training.

▼ Intake radar
The cone in the middle of the intake housed the antenna for the MiG's air-to-air radar.

Rocket take-off ▶
To get into the air as quickly as possible, the MiG-21 could augment the power of its single engine with a pair of strap-on rockets. These produced blistering take-offs and gut-churning climbs.

Defender of the Motherland ▶
Second-generation MiG-21s with upgraded avionics and engines first saw service with Soviet air defence forces. Large numbers remain in service with ex-Warsaw Pact forces.

FACTS AND FIGURES

- The MiG-21 racked up a seven to one victory streak against Americans over North Vietnam in 1967–68.
- The E-66 MiG-21 prototype zoom-climbed to an altitude of 34,714 m (113,891 ft).
- The MiG-21 has been operated by nearly 50 air forces in the last 35 years.
- At least 14 versions of the MiG-21 have been built.
- Israeli pilots in the 1970s said the MiG-21 was the best enemy fighter they had met.
- In 1979, 'Fishbeds' in frontline Soviet service outnumbered the fighter strength of all NATO air forces.

PROFILE

The world's most popular fighter

The 'Fishbed' was popular with pilots, although by modern standards the aircraft had poor radar and endurance.

As American pilots were to learn over Hanoi, the 'Fishbed' (the West's nickname) was a serious adversary. Soviet aircraft often use crude construction techniques, but many, such as the MiG-21, compensate for a lack of glamour with hard-hitting combat power. One of the most manoeuvrable warplanes of its era, it could wriggle its way out of a trap and score the kill.

With its familiar clipped delta wing and nose intake (with a spike sticking out like the point of a nail), the Mikoyan-Gurevich MiG-21 was easy to recognize and instantly respected by any opponent. Conceived after the Korean War as an interceptor, the supersonic MiG filled many combat roles and has undergone frequent improvements in its powerplant and electronics.

In the right hands, the MiG-21 could turn the mighty F-4 Phantom into meat on the table. American fighters were more sophisticated and flew further, but none was a match for the MiG-21 in a close-quarter battle.

The MiG-21 has been built in a bewildering number of variants, including two-seaters for training. The later fighter aircraft have a large humped spine which carries extra fuel.

The MiG-21 was what was called a 'tailed delta'. Combined with the powerful engine, this made the type one of the nimblest fighters of its era – more than a match in a close-in dogfight for the heavy Phantom, which opposed it in Vietnam and in the Middle East.

MiG-21MF 'Fishbed'

Type: single-seat interceptor and fighter

Powerplant: one 63.65-kN (14,316-lb-thrust) Tumanskii R-13 afterburning turbojet engine

Maximum speed: 2230 km/h (1,386 mph)

Range: 1480 km (917 miles)

Service ceiling: 18,500 m (60,696 ft)

Weights: empty 5350 kg (11,795 lb); loaded 9400 kg (20,723 lb)

Armament: one twin-barrel 23-mm (0.91-in) GSh-23 cannon with 200 rounds; four wing pylons for heat-seeking or radar-guided 'Atoll' air-to-air missiles; up to 2000 kg (4,409 lb) of bombs or rocket pods

Dimensions:

span	7.15 m (23 ft 5 in)
length	15.76 m (51 ft 8 in)
height	4.50 m (14 ft 9 in)
wing area	23.00 m² (248 sq ft)

Even though the Indian air force operates more modern combat aircraft, such as the Mirage 2000, its many MiG-21s are still a vital element in its order of battle.

MiG-21FL 'Fishbed'

India is one of the most important users of the MiG-21, and has taken the aircraft into combat against Pakistan. India values its 'Fishbeds' so highly that it is upgrading them with new radars and modern systems.

When the MiG-21 was in its heyday, its pilots were the élite of the Soviet air defence forces.

Three different types of engine powered the MiG-21 through its production life, all made by MNPK 'Soyuz' (Tumanskii). The first aircraft had an R-11 of 60.56 kN (13,621 lb thrust), mid-period aircraft had the 63.65-kN (14,316-lb-thrust) R-13, and the final aircraft had the much better R-25 of 69.63 kN (15,661 lb thrust).

The MiG-21's main weapon was the AA-2 'Atoll' heat-seeking missile. This was a pirated copy of the West's Sidewinder.

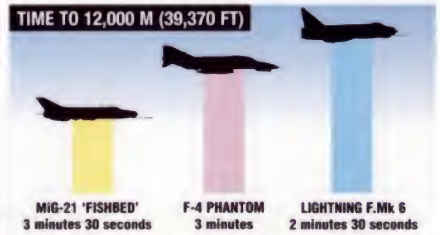
This version of the 'Fishbed', the MiG-21FL, did not have any internal guns, but carried a 23-mm (0.91-in) cannon pack under the fuselage.

COMBAT DATA

MAXIMUM SPEED

The MiG-21 was one of the first fighters capable of twice the speed of sound, and is still one of the fastest fighters around. The contemporary Lightning and Phantom are faster, but both have two engines.

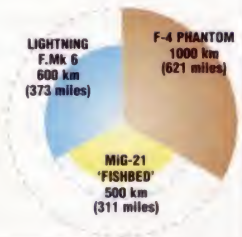
TIME TO 12,000 M (39,370 FT)

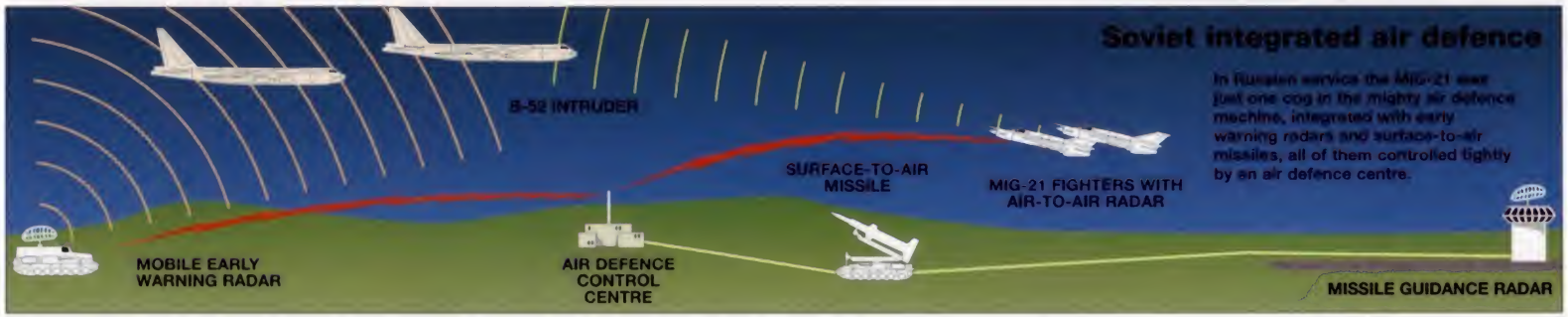


Designed as an interceptor, the MiG can get to a bomber's operating height in a matter of minutes. Only the brute power of the Lightning gives it an advantage. The Phantom is just as powerful, but is twice the size and weight of the Russian jet.

COMBAT RADIUS

Afterburning jets use a lot of fuel, and the first generation of Mach 2 fighters had poor endurance by modern standards. But the MiG-21 was designed as a fast-climbing point-defence weapon, and did not really need long range. Nor did it ever acquire an air-to-air refuelling capability.





MIKOYAN-GUREVICH

MiG-23 'FLOGGER'

● Swing-wing fighter ● High-performance interceptor

To most of the world, the word 'MiG' means 'Soviet fighter'. The MiG-23 'Flogger' is perhaps the least glamorous warplane bearing its famous name. Derided over the years as being ineffective, this tough and reliable swing-wing fighting jet has come in for a reappraisal. Available in interceptor and ground-attack versions, 'Floggers' have been built in large numbers and have seen action all over the world.

▲ *Written off initially as a 'poor man's Phantom', the MiG-23 is not easy to fly. But it has extremely good acceleration, high top speed and simple-to-use avionics, and is highly adaptable.*

PHOTO FILE

MIKOYAN-GUREVICH MiG-23 'FLOGGER'

▲ Polish air defender
Armed with a brace of R-60 missiles under the belly and wing-mounted R-23s, a Polish MiG-23 stands ready to scramble.

▲ Dogfight story
Soviet MiG-23 pilots relive a training fight. Not the most agile of fighters, in experienced hands the 'Flogger' could nevertheless give a good account of itself.

Mixed MiG formation ▶
A 'Flogger' flies with two 'Fulcrums', slower but more agile successors to the MiG-23.

▼ Eastern favourite
The MiG-23MF was exported to Czechoslovakia, Germany, Hungary, Poland and Romania.

Bullet nose ▶
The sharp profile of the MiG-23 shows that it was meant to go very fast if need be. Later versions could even out-accelerate the Lockheed Martin F-16 Fighting Falcon.

▶ Mission ready ▲
A MiG-23 prepares for flight. Like most jets designed in the Soviet era, the MiG-23 can operate from semi-prepared strips, thanks to its swing wing and tough undercarriage.

FACTS AND FIGURES

- Development of the MiG-23, successor to the MiG-21, began in the early 1960s.
- The MiG-23 was first seen by the West at an air show near Moscow in June 1967.
- A typical MiG-23 carries 5380 litres (1,421 US gal) of internal fuel and up to 2370 litres (626 US gal) in external tanks.
- Its variable-geometry wing allows the MiG-23 to fly from short tactical runways.
- Two Libyan MiG-23s were shot down by US Navy F-14 Tomcats in 1989.
- Export MiG-23s have not done well in combat, due mainly to pilot inexperience and their downgraded avionics fit.

PROFILE

The variable-geometry 'Flogger'

More of a bully than a beauty, the MiG-23 'Flogger' is a contemporary of the West's F-4 Phantom. Both are powerful. Both are versatile. Both are rewarding aircraft from the pilot's point of view, and both succeed at their grim military business. Both make effective use of powerful engines, superb radar and muscular weapons-carrying capacity.

But while the Phantom is a two-seater with a fixed wing, most MiG-23s are single-seat aircraft with a variable-geometry wing which sweeps forward for good performance at low speeds and backward for high-speed flight.

The MiG-23 equipped nearly all allies of the former Soviet Union, and was still being refined and improved three decades after entering service. Its combat record was mixed. Arab forces lost large numbers of the aircraft to the Israelis, but this was more to do with disparity in training than any superiority of Western designs.

The MiG-23 may have been overshadowed by its successors, but the sheer numbers of this aircraft mean that it will remain an important combat type for many years to come.

No longer at the cutting edge of technology, the MiG-23 'Flogger' remains amenable to further development even as it gathers age, and it remains a hard-hitting weapon of war.

With its wing in the forward position, the MiG-23 can safely land slowly on rough surfaces. With the wing swung back, it can outrun almost anything in the skies.

MiG-23ML 'Flogger-G'

Type: single-seat strike fighter

Powerplant: one Soyuz (Tumanskii) R-35-300 turbojet rated at 127.5 kN (28,676 lb thrust) with afterburner

Maximum speed: 2500 km/h (1,553 mph) at 12,500 m (41,010 ft)

Range: 2800 km (1,740 miles)

Service ceiling: 18,000 m (59,055 ft)

Weights: empty 8200 kg (18,078 lb); loaded 17,800 kg (39,242 lb)

Armament: one 23-mm (0.91-in) GSh-23L twin-barrel cannon; 2000 kg (4,410 lb) of 57-mm (2.24-in) and 80-mm (3.15-in) rocket projectiles, UPK-23-250 or SPPU-22 gun pods, AS-7 'Kerry' missiles or bombs

Dimensions:

span	13.95 m (45 ft 2 in)
length	16.70 m (54 ft 9 in)
height	4.80 m (15 ft 9 in)
wing area	37.35 m² (402 sq ft)

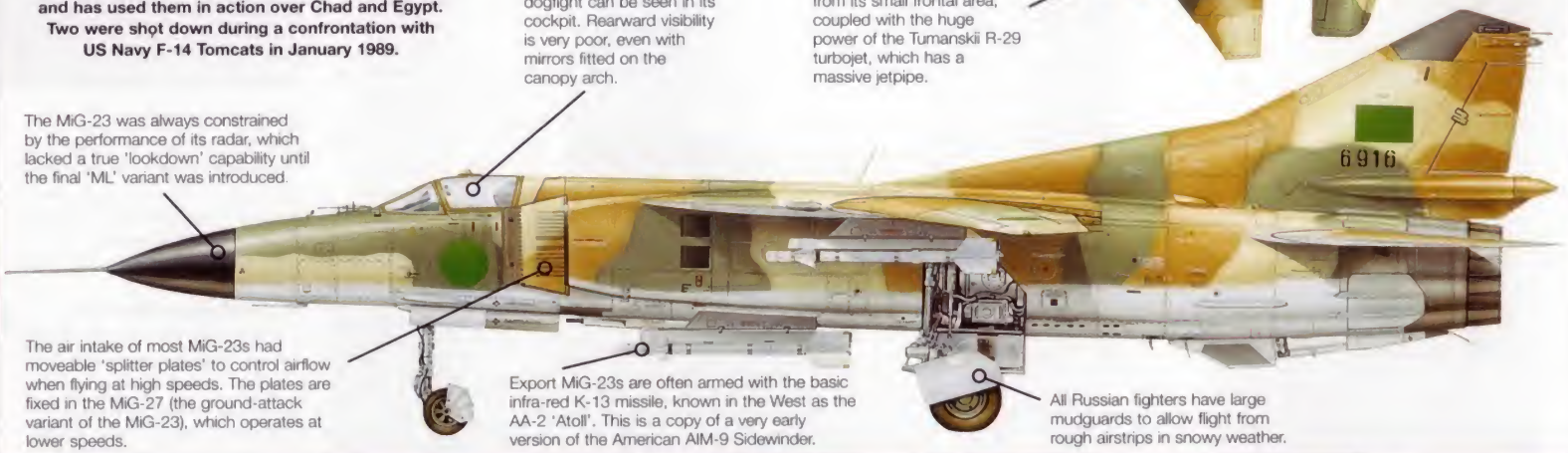
MiG-23MS 'Flogger-E'

Libya has received large numbers of the MiG-23MS, and has used them in action over Chad and Egypt. Two were shot down during a confrontation with US Navy F-14 Tomcats in January 1989.

The fact that the MiG-23 was not designed to dogfight can be seen in its cockpit. Rearward visibility is very poor, even with mirrors fitted on the canopy arch.

The MiG-23 gains its speed from its small frontal area, coupled with the huge power of the Tumanskii R-29 turbojet, which has a massive jetpipe.

The MiG-23 was always constrained by the performance of its radar, which lacked a true 'lookdown' capability until the final 'ML' variant was introduced.



The air intake of most MiG-23s had moveable 'splitter plates' to control airflow when flying at high speeds. The plates are fixed in the MiG-27 (the ground-attack variant of the MiG-23), which operates at lower speeds.

Export MiG-23s are often armed with the basic infra-red K-13 missile, known in the West as the AA-2 'Atoll'. This is a copy of a very early version of the American AIM-9 Sidewinder.

All Russian fighters have large mudguards to allow flight from rough airstrips in snowy weather.

Swing-wing solutions

FULL WING SWING: The Panavia Tornado's wings swing from the wingroots, necessitating an extremely complex hinge construction built onto the fuselage. This allows all of the wing to be swept for high speeds and extended for low speeds, but presents a considerable engineering challenge and one that costs a great deal of time and money to perfect.

SWINGING FROM THE MIDDLE: The MiG-23 was one of the first operational variable-geometry aircraft. To simplify engineering problems, MiG's designers decided to move only those sections of the wing that were clear of the fuselage, leaving a small part fixed. That way, they could move the wing hinges away from the body of the plane, making for much less complex construction.

WING-TIP SWING: The huge Tupolev swing-wing bombers such as the 'Backfire' and 'Blackjack' utilize the simplest swing wings, pivoting only the outer portions. While less efficient at low speeds than a fully moveable wing, they still significantly cut landing speeds. Fully swept, they are just as effective.

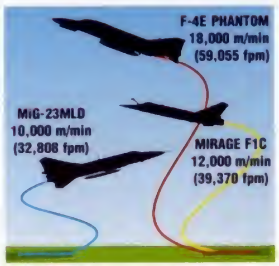
COMBAT DATA

MAXIMUM SPEED

Even today, almost four decades after its first flight in 1967, the MiG-23 remains one of the fastest fighters in the world. Its immensely powerful Tumanskii turbojet propels the fighter to Mach 2.5 with wings swept back at 72°. With wings at a minimum sweep of 16°, speed is limited to the subsonic regime, with a maximum of 940 km/h (584 mph).

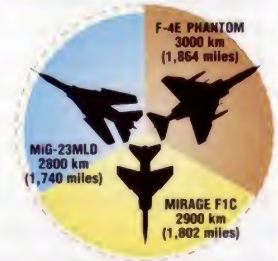
CLIMB RATE

Although powered by a potent engine, the MiG-23 cannot match the sheer brute twin-engined power of its great American rival. But the big and heavy Phantom cannot climb as high as the 'Flogger', nor can it accelerate as rapidly in level flight.



RANGE

No fast jet combat aircraft developed in the 1960s is notable for its range, although all have respectable ferry ranges. In combat, however, radius of action is dramatically reduced, and using the afterburner cuts endurance to a matter of minutes.



MIKOYAN-GUREVICH

MiG-25 'FOXBAT'

● World's fastest fighter ● Mach 3-capable ● Soviet defender

For a decade the word 'Foxbat' struck terror into the hearts of NATO planners. The appearance of the needle-nosed Soviet interceptor, bristling with missiles, and its startling Mach 3, high-altitude performance signalled the dawn of a new era in Cold War aviation. As time passed the 'Foxbat' gave up some of its secrets, and analysts came to understand its strengths and weaknesses. However, while it is no longer the awesome warplane it once was, it is still an impressive machine.

▲ *The MiG-25 is the world's fastest operational interceptor. It is also one of the biggest: this Indian pilot and ground crew are dwarfed by the huge machine.*

PHOTO FILE

MIKOYAN-GUREVICH MiG-25 'FOXBAT'

▼ Export 'Foxbats'
MiG-25s were exported to a few favoured nations, such as Libya (shown here), Syria, India, Iraq, Algeria and Bulgaria.

▲ Brute force
The MiG-25 achieves its amazing performance through sheer power rather than by any smart aerodynamics.

◀ At full throttle
One can almost feel the power of the twin Tumanskii R-15 engines as a MiG-25 launches. Between them the two mighty turbojets produce 219.68 kN (49,409 lb thrust) in full afterburn.

▲ Trials aircraft
This MiG-25, seen at Moscow's Zhukhovski trials base, is a flying laboratory; it has an open rear cockpit to test ejection seats at high supersonic speeds. The pilot flies from the front cockpit.

◀ Windfall for the West
In 1976 Soviet air force pilot Viktor Belenko defected in a MiG-25. Its arrival in Japan allowed Western experts to analyse this hitherto unknown quantity before it was returned to the Soviet Union.

FACTS AND FIGURES

- Viktor Belenko's defection to Japan in a MiG-25 in 1976 was considered the biggest spy coup of the Cold War.
- Soviet-piloted Egyptian MiG-25s flew against Israel between 1971 and 1975.
- At maximum speed, the MiG-25's canopy is too hot to touch with the naked hand.
- 'Foxbats' fly in Algeria, Azerbaijan, Belarus, Bulgaria, India, Iraq, Kazakhstan, Libya, Russia, Syria and the Ukraine.
- The MiG-25BM is designed to attack an enemy's air defence radars from great distance and height.

PROFILE

Three times the speed of sound

Although it is growing old now, the Mikoyan-Gurevich MiG-25 'Foxbat' is one of the most amazing performers ever built. The MiG-25 was a panic response to the American B-70 bomber of the 1960s, but after the B-70 was cancelled Moscow went ahead with this incredibly powerful, heavily armed interceptor, and 'Foxbat' became a scare word in the Pentagon after the first MiG-25 was glimpsed briefly in July 1967. Except for the (unarmed) SR-71 Blackbird, the West has never had a craft able to reach the speeds and altitudes where the 'Foxbat' routinely flies every day.

The pilot of the MiG-25 rides high in the cockpit of a truly massive single-seater. He can fly at more than 5 km (3 miles) higher than any of his Western contemporaries. He can close in for the kill at far greater speed, or complete his reconnaissance mission with overwhelming chances of success. The Israeli air force sought in vain to catch Soviet-piloted 'Foxbats' that once flew from Egypt, and the 'Foxbat' remains a potent force today. During the 1991 Gulf War, an Iraqi MiG-25 is believed to have claimed the only coalition aircraft (an F/A-18) shot down in an air-to-air battle.

There are many MiG-25s configured for reconnaissance, in a multitude of variants. This MiG-25RBK has a large side-looking radar in the nose.

MiG-25 'Foxbat-A'

Type: high-performance all-weather interceptor

Powerplant: two 109.84-kN (24,704-lb-thrust) Tumanskii R-31 afterburning turbojets

Maximum speed: up to Mach 3, although normally limited to Mach 2.8 or 3120 km/h (1,939 mph)

Range: 1700 km (1,056 miles) subsonic with internal fuel

Service ceiling: 24,000 m (78,740 ft)

Weights: empty 20,000 kg (44,092 lb); loaded 36,200 kg (79,807 lb)

Armament: four AA-6 'Acrid' long-range air-to-air missiles, or two AA-6 and two AA-7 'Apex' missiles; other missiles in other combinations

Dimensions:

span	13.95 m (45 ft 9 in)
length	23.82 m (78 ft 2 in)
height	6.10 m (20 ft)
wing area	56.83 m² (612 sq ft)

MiG-25BM 'FOXBAT-F'

Based on the multi-role MiG-25RB, the 'Foxbat-F' is a specialized defence suppression aircraft. Unlike American 'Wild Weasels', it is designed to attack enemy radars from high altitude at very long range.

The MiG-25's large highly swept wings, twin fins and variable intakes are a sophisticated combination which give maximum stability and manoeuvrability at high speeds.

The 'Foxbat' introduced the twin vertical tails now common on high-performance combat jets. A single tail with the same effect would have needed to be much larger and stronger.

The left fin cap houses the main VHF communications antenna. The starboard equivalent contains ECM and IFF gear.

Although painted to appear like a radar-equipped fighter, the MiG-25RB does not carry air-to-air electronics.

As the MiG-25 was designed for speed rather than dogfights, its cramped cockpit reflects a need for low drag rather than all-round visibility.

Part of the reason for the MiG-25's blistering performance is the immense power it gets from two huge Tumanskii turbojets. Each delivers more than 11 tonnes (12 tons) of thrust.

In place of the normal radar, the nose of the 'Foxbat-F' houses passive detection devices designed to pick up hostile radar transmissions.

As with most combat jets of the Soviet era, the MiG-25 has a rugged undercarriage, allowing it to operate from rougher fields than Western fighters.

As a defence suppression aircraft, the 'Foxbat-F' is armed with radar-homing missiles. The supersonic Kh-58 (NATO designation AS-11 'Kilter') has a range in excess of 50 km (31 miles).

The MiG-25 is mostly made from steel, rather than the hugely expensive titanium used in Western aircraft of similar performance.

High-altitude interceptor

MiG-25: The 'Foxbat' was designed to tackle the mighty B-70 Valkyrie and later to counter the SR-71 Blackbird, although it had little chance of catching the latter.

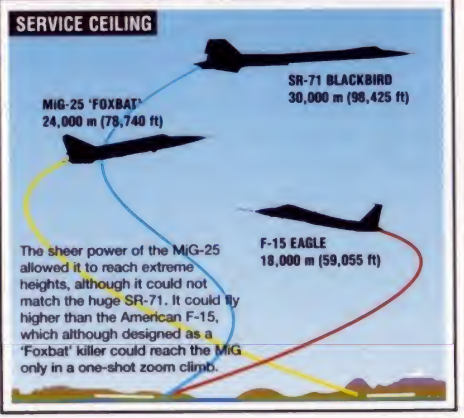
NORTH AMERICAN B-70: The monster Valkyrie was a high-altitude Mach 3 bomber. Even though it was cancelled, the Soviets continued with the development of the MiG-25.

BOEING B-52: The USAF's main strategic bomber was easy meat for the MiG-25 and MiG-21. However, when cruise missiles appeared on the B-52 the MiG-25 was hastily redesigned with a new radar which could detect and track these low-flying targets.

MiG-21: Early Soviet interceptors such as the MiG-21 and Su-15 had sufficient performance to kill the B-52, but could never have got near the B-70.

COMBAT DATA

SERVICE CEILING



MIKOYAN

MiG-27 'FLOGGER-D/J'

● Ground attack ● Close air support ● Anti-shipping strike

Based on the MiG-23BM, the MiG-27 is a dedicated ground-attack aircraft and is equipped with a six-barrelled 30-mm (1.18-in) cannon for use against ground targets. The undercarriage is strengthened so that it can carry the additional weight of air-to-surface stores, including nuclear weapons, and the air intakes are simplified. It is fitted with a comprehensive array of antennas and sensors for targeting and self-protection.

▲ *The MiG-27 was popular with the pilots who flew the aircraft in combat over Afghanistan, improving their operational techniques. Various modifications to the aircraft resulted from these operations.*

PHOTO FILE

MIKOYAN MiG-27 'FLOGGER-D/J'

◀ The Indian Valiant
India licence-builds the MiG-27M, and in Indian air force service it is known as the 'Bahadur' (Valiant).

▼ Frontal aviation
The MiG-27 has been an important asset to Russia's air armies since the mid-1970s.

▲ Tactical deployment
MiG-27s armed with tactical nuclear weapons were on strength at Soviet bases across East Germany until 1992.

▼ Commonality
The Soviet MiG-27 shared components with the MiG-23, but was dedicated to the ground-attack role.

▲ Rough-field capability
The rugged MiG-27 has been designed to operate from hastily prepared forward air bases with minimum ground support. Take-offs are kept as short as possible by using reheat.

FACTS AND FIGURES

- The Mikoyan MiG-27 was chiefly developed because of the Soviet's dissatisfaction with the MiG-23BN.
- For ground-strafing MiG-27s carry SPPU-22 gunpods with articulated barrels.
- To confuse enemy defences the MiG-27 has a powerful thermal jammer.
- The MiG-27's fixed intakes and splitter plates 80 mm (3.15 in) from the fuselage wall distinguish it from the MiG-23BN.
- Russian air force MiG-27s can carry the TN series of tactical nuclear weapons.
- The MiG-27K has an internal smoke emitter for laying battlefield screens.

PROFILE

'Ducknose', the strike fighter

Both the original MiG-27 and the MiG-27K version were known in the West by the NATO designation of 'Flogger-D'. The -27K, however, possessed a new navigation and attack system, including a laser rangefinder in the nose, that made it capable of highly accurate blind bombing.

Further equipment improvements produced the MiG-27M, or 'Flogger-J'. This is equipped to launch missiles and precision-guided munitions. Later versions carried various additional systems, including forward-looking infra-red sensors and specialized navigation systems for the nuclear-strike role.

Soviet forces used MiG-27s during the later stages of the war in Afghanistan in 1987–89. They were fitted with dispensers for chaff and flares to help protect them against any surface-to-air missiles used by the Mujahideen guerrillas.

The subsequent break-up of the Soviet Union left MiG-27s in the hands of several of the newly independent states, such as the Ukraine. Other than these examples, however, the only MiG-27s to serve outside Russia are those operated by India, which actually built many of its own MiG-27Ms.

Below: The original MiG-27K 'Flogger-D' has now been supplanted in the Russian air force by the improved MiG-27M 'Flogger-J' and '-J2', with provision to carry more precision-guided munitions.

Above: The Russian air force is now beginning to phase out its older MiG-27s in favour of newer multi-role types. The aircraft remains a very important weapon for India, however.

MiG-27K 'FLOGGER-D'

In the 1980s the West's intelligence sources were confident that the MiG-27 had been widely exported to the Soviet's allies, including Syria (whose markings are shown below). However, India and the former Soviet republics are the only operators of the aircraft.

MiG-27M 'Flogger-J'

Type: single-seat ground-attack and close air support aircraft

Powerplant: one 112.77-kN (25,363-lb-thrust) MNPK Tumanskii R-29B-300 turbojet

Maximum speed: 1885 km/h (1,171 mph)

Initial climb rate: 12,000 m/min (39,370 fpm)

Combat radius: 540 km (336 miles) loaded at low level

Service ceiling: 14,000 m (45,932 ft)

Weights: maximum take-off 20,300 kg (44,754 lb)

Armament: one GSh-6-30 six-barrel 30-mm (1.18-in) gun, plus 5000 kg (11,023 lb) of weapons on seven pylons

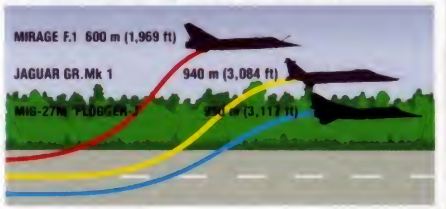
Dimensions:

span	13.97 m (45 ft 10 in)
length	17.08 m (56 ft)
height	5.00 m (16 ft 5 in)
wing area	37.35 m² (402 sq ft)

COMBAT DATA

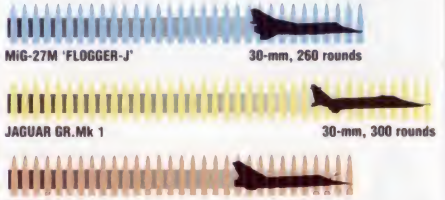
TAKE-OFF DISTANCE

Ground-attack aircraft can extend their time over the target by using forward air strips, which are often very short pieces of disused road or damaged airfields. The figures given are for maximum weapon load, typical for a frontline mission.



INTERNAL GUNS

Unlike dedicated air-defence aircraft, which are equipped with less devastating but higher velocity cannon, the MiG-27 and its rivals in the ground-attack role use 30-mm (1.18-in) cannon. These rounds are far heavier than those used by the air-defence machines.

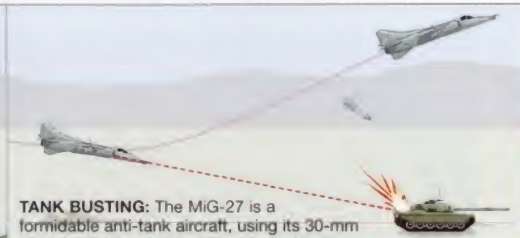


COMBAT RADIUS

Equipped with two Kh-29 missiles and three 790-litre (209-US gal) drop-tanks, the MiG-27 has a useful range. With maximum weapon load, range is reduced to 225 km (140 miles) with internal fuel only at low altitude. The Jaguar has especially long range due to the efficient Adour engine.

Combat missions

AIRFIELD STRIKE: Armed with 500-kg (1,100- lb) bombs and KMGU bomblet dispensers, the MiG-27 is suited to low-level attacks.



TANK BUSTING: The MiG-27 is a formidable anti-tank aircraft, using its 30-mm (1.18-in) Gatling gun combined with Kh-29 precision-guided air-to-surface missiles. For self-protection it is equipped with chaff, smoke and flares.

ANTI-SHIPPING: Russian navy MiG-27Ms are equipped to carry the Kh-31 long-range ramjet-powered anti-ship missile. These aircraft are tasked with the protection of Russian shipping lanes and are based on the Kola Peninsula.

MIL

MI-8 'HIP'

● Assault transport ● Civil helicopter ● Gunship

A tough and resilient combat veteran, the Mil Mi-8 'Hip', and the closely related Mi-17, stands tall in its reputation as one of the most versatile helicopters in the world. The Mi-8 is the most widely used helicopter in service, and is cheap to run, easy to maintain and powerful. The 'Hip' is primarily a troop carrier and civil transport. Other roles include helicopter gunship, airborne command post, search and rescue and even communications jamming.

▲ *One of the most enduring rotary designs ever, the Mi-8 has all the typical attributes of a Mil machine, combining strength and simplicity in a well-proven low-cost airframe.*

PHOTO FILE

MIL MI-8 'HIP'

▼ Shooting from the hip

The 'Hip-E' gunship version is one of the world's most heavily armed helicopters, and has been used extensively in Chechnya.

▲ Santa's sleigh

Even Santa Claus used the Mi-8 when travelling in distant areas of the Soviet Union. The Mi-8 was also vital to the Soviet oil industry, which explored in very remote areas.

Tourist flyer ▶

This Mi-8, belonging to Avialini Baltiski, flies tourists over St Petersburg on short pleasure flights in the summer.

▼ Assault transport

This Mi-8 of the Indian air force is landing troops close to the front. Soviet Mi-8s made thousands of air assaults in Afghanistan, and large numbers were shot down.

▲ KGB transport

Guarding the huge borders of the Soviet Union, the KGB needed a large number of Mi-8s to transport dog teams.

FACTS AND FIGURES

- More than 10,000 Mi-8s and Mi-17s have been built, with many hundreds being exported to more than 40 operators.
- The Mil Mi-17 is basically a Mi-8 with more power and a new tail rotor.
- The rare Mi-8PPA is a special communications jammer variant.
- The Mi-8 has fought in Afghanistan, Angola, Chechnya, Egypt, Mozambique and Nicaragua.
- The Czech Republic, Hungary and Russia use the 'Hip-G' command post version.
- The Mil Mi-14 'Haze' anti-submarine helicopter is derived from the Mi-8.

PROFILE

Helicopter workhorse to the world

Design of the Mi-8 'Hip' began in 1960. Unlike the earlier Mi-4 'Hound' which had its engine mounted in the nose, the Mi-8 has a more efficient shape with the turboshaft powerplant above the fuselage leaving maximum space for payload. Except on specialized models, large clamshell doors swing open at the rear fuselage.

Nearly a dozen versions of the Mi-8 and its upgraded Mi-17 derivative were used by Soviet forces and exported to Moscow's allies, and thousands of examples remain in service in Russia and around the world. Despite the age of the basic design, the type remains in production and sales continue. From the Arctic tundra of Finland to the tropical jungles of Peru, the 'Hip' is always a formidable performer, whether dropping into a landing zone with a load of troops or flying scheduled airline or cargo services to remote settlements.

Military Mi-8s are often equipped to a high specification, including additional cockpit armour, infra-red jammers, chaff and flare dispensers and exhaust gas diffusers. The Mi-17 improved upon the original Mi-8 by introducing a titanium rotor head for greater strength, improved efficiency engines and a new gearbox.

Mi-8s belonging to Interflug, former state airline of the DDR, have now all been retired.

The Mi-8 was cheap enough to produce in thousands, giving the Red Army mass airlift capability.

Mi-8T 'Hip-C'

Type: assault transport helicopter

Powerplant: two 1104-kW (1,480-hp) Klimov (Isotov) TV-2-117A turboshaft engines

Maximum speed: 250 km/h (155 mph) at sea level

Typical cruising speed: 208 km/h (129 mph)

Radius of action: 350 km (217 miles)

Ferry range: 930 km (578 miles)

Service ceiling: 4500 m (14,764 ft)

Weights: typical empty 7160 kg (15,875 lb); loaded 12,000 kg (26,455 lb)

Accommodation: up to 28 combat troops in a cabin area behind pilots; combinations of rockets or 250-kg (550-lb) bombs or UV-16-57 rocket pods (16 x 57-mm/2.24-in projectiles each) astride the fuselage

Dimensions:

main rotor	diameter	21.29 m (69 ft 10 in)
	length	25.24 m (82 ft 10 in)
	height	5.65 m (18 ft 6 in)
	main rotor disc area	356.00 m² (3,832 sq ft)

Mi-8T 'Hip-C'

The Mi-8 remains in service in very large numbers with Aeroflot's successor airlines in the former Soviet Union, such as Baltiski, Baikal Avia, Orbi, Tajik Air and Tatarstan, as well as with many military air arms.

Although slightly redesigned, the Mi-8's large five-bladed main rotor was also used by the later Mi-24 gunship. Like all Mil designs, it rotates clockwise when viewed from above. The rotors have an automatic ice detection and thermal de-icing system, essential for operations in Russian conditions.

The Mi-8 has a traditional rotor head with flapping hinges and bearings. The improved titanium rotor head of the Mi-17 needs less maintenance and is more bullet resistant.

The Isotov TV-2 engines of the Mi-8 are very similar to the TV-3 engines in the Mi-24 and Mi-17. The TV-3 proved more reliable and economical and dramatically improved performance in 'hot-and-high' conditions.

In the Mi-8 the tail rotor is on the starboard side of the tail, but on the port side of the Mi-17.

The Mi-8 cockpit is surprisingly large. Israeli pilots flying captured examples in 1973 found that the machine had a totally different feel in flight to Western helicopters, and could easily outrun many of them.

Loading a Mi-8 is easy, thanks to the clamshell doors at the rear which can accommodate wide cargoes and allow infantry to exit very swiftly in an assault.

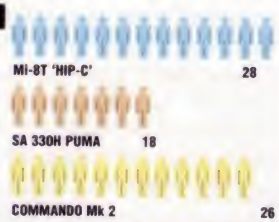
ACTION DATA

MAXIMUM SPEED

Typical top speeds for this type and size of helicopter tend to be around 250 km/h (155 mph). The Puma had a marginal edge in this respect, with a better power-to-weight ratio.

TROOP CAPACITY

The Commando and Mi-8 can carry large numbers of troops. The Puma was designed to transport only a small platoon of infantry, and has a narrow fuselage compared to the much roomier Mi-8 and Commando.



Mil's multi-role 'Hip'

Mi-8 'HIP-A': The first Mi-8 was the single-engined prototype that lacked power and only had a four-bladed main rotor.

Mi-8 'HIP-C': With two engines and five main rotor blades, the Mi-8 'Hip-C' became the main assault helicopter of the USSR.

Mi-8 'HIP-E': Probably the most heavily armed helicopter in service, the 'Hip-E' carried up to six pods of 32 rockets.

Mi-17 'HIP-H': The Mi-17 featured new engines, gearbox and rotor shaft and was a lot more powerful and economical than the Mi-8.

AWACS HIP: The Mi-17 was even converted to act as an airborne early warning and control machine with side-mounted radar aerials.

MIL

MI-14 'HAZE'

● Twin-engined shore-based ASW/SAR helicopter ● Exports

▲ *Entering production in 1978, more than 240 Mi-14 'Haze-As' were built. The 'Haze' family has been the Soviet Bloc's principal source of shore-based ASW and SAR helicopters.*

Based on the Mi-8 'Hip', the Mi-14 was developed as a land-based anti-submarine helicopter in the early 1970s. A boat hull and retractable landing gear were used to make it suitable for amphibious operations, with more powerful engines compensating for the additional weight. Flight tests started in September 1969. Specialised versions for minesweeping and search-and-rescue operations have also been produced.

PHOTO FILE

MIL MI-14 'HAZE'

◀ Export potential
This Mi-14P was displayed at the Mosaero air show in 1995. It has a new nose radome in place of the undernose fairing and a searchlight.

▼ Amphibious 'Haze' at sea
The boat hull shape of the Mi-14's lower fuselage is supplemented by floating bags, which are useful when retrieving personnel in the SAR role or if the aircraft is forced to ditch.

▼ Upgraded Mi-14 demonstrator
To 'drum up' business, the Russian aviation industry is offering upgrades for existing airframes.

▼ Land based
As featured on other maritime helicopters such as the Sikorsky Sea King, the Mi-14 has a shaped hull to provide an amphibious capability.

▲ 'Haze' underside
This view of an Mi-14's underside shows the large weapons bay doors open and the MAD 'bird' deployed. Other apertures in the rear of the fuselage house dipping sonar and include parachutes for sonobuoys and flares.

FACTS AND FIGURES

- The Mi-14PL 'Haze-A' entered service in 1976, the Mi-14BT 'Haze-B' followed in 1986 and the Mi-14PS 'Haze-C' in 1992.
- Poland was the only export customer for the search-and-rescue Mi-14PS.
- East German Mi-14s were retired after the German reunification.
- The engine and gearbox from the Mi-17, itself developed from the Mi-8, was installed in the Mi-14.
- The SAR 'Haze-B' carries ten 20-place life-rafts and can tow these when filled.
- Mi-14PLs carry four crew: two pilots, a flight engineer and a systems operator.

PROFILE

Soviet ASW and SAR patroller

Equipped with a search radar, dipping sonar, dispensers for sonobuoys and flares and a towed magnetic anomaly detector (MAD), the original anti-submarine version of the 'Haze' was the Mi-14PL. The Mi-14PLM is a later variant with an improved engine and has the search radar moved to the bottom rear end of the fuselage.

For minesweeping, the Mi-14BT 'Haze-B' has a mine-activating sled in place of the MAD. Towed behind the helicopter, it carries either electrical cables or noise generators to detonate magnetic or acoustic mines. A searchlight on the tailboom enables the sled to be launched and recovered at night. The BT variant was used by the former East German navy, as well as the Soviet naval air arm, although only about 25 were built. The Luftwaffe did not keep the East German navy's six Mi-14BTs after reunification. Some have been converted to water bombers for use in civilian fire-fighting operations.

Above: Mi-14PL export markets included Bulgaria, Cuba, East Germany, Libya, North Korea, Poland, Syria and Yugoslavia.

The search-and-rescue version of this helicopter is known as the Mi-14PS 'Haze-C'. It has a more powerful winch and a wider main door, and is fitted with searchlights in the nose. The only users of the 'Haze-C' are Russia and Poland.

Below: The 'Haze' usually carries a flight crew of three, although the anti-submarine variants also have a systems operator for the sonar equipment and weapons.

Mi-14PL 'Haze-A'

Type: land-based anti-submarine helicopter

Powerplant: two 1434-kW (1,923-hp) Klimov (Isotov) TV3-117MT turboshafts

Maximum speed: 230 km/h (143 mph) at sea level

Climb rate: 468 m/min (1,535 fpm) at sea level

Endurance: 5 hours 55 min

Range: 1135 km (705 miles) with maximum fuel

Service ceiling: 4000 m (13,123 ft)

Weights: empty 8902 kg (19,626 lb); loaded 13,000 kg (28,660 lb); maximum take-off 14,000 kg (30,865 lb)

Armament: torpedoes and depth charges, as well as sonobuoys/smoke/flare floats

Dimensions:

main rotor	diameter	21.29 m (69 ft 10 in)
	length	18.37 m (60 ft 3 in)
	height	9.63 m (31 ft 7 in)
	rotor disc area	362 m² (3,897 sq ft)

Mi-14PL 'Haze-A'

This Mi-14PL serves with the Polish navy, which also operates an Mi-14PX in the SAR training role and a small number of Mi-14PS 'Haze-C' dedicated SAR machines.

The underfuselage radome contains a Type 12-M search radar. A watertight weapons bay on the centreline can carry depth charges and torpedoes.

In common with the Mi-8 'Hip' from which it was developed, the Mi-14 has a five-blade main rotor. A three-blade tail rotor is fitted on the left side of the tail boom, as on the improved Mi-17.

This aircraft wears a commonly used low-visibility grey colour scheme. East German examples were painted in a dark shade of blue.

To assist during personnel recovery, a 150-kg (330-lb) hoist is fitted above the main cabin door.

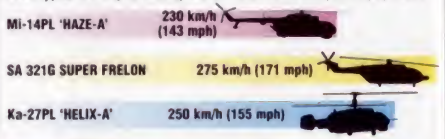
The MAD 'bird' stowed behind the rear fuselage is used to detect submarines. Magnetic anomalies may be caused by the presence of a large metallic mass, such as a submarine.

The fuselage sponsons and tail float both contain flotation gear for use if the helicopter ditches at sea. The tail float prevents the tail rotor touching the water during an on-water landing.

COMBAT DATA

MAXIMUM SPEED

Aircraft such as the Mi-14 were not intended to be high-speed machines, range and endurance were more important factors. All three types are capable of speeds in the 250 km/h (155 mph) band.

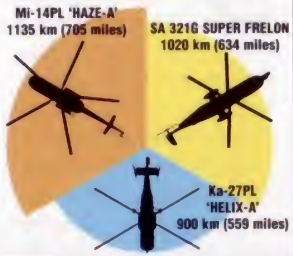


ENDURANCE

The land-based Mi-14 has the best endurance of these representative types. 'Helix' is a smaller carrier-based machine, and the Super Frelon has three engines and a higher fuel consumption.

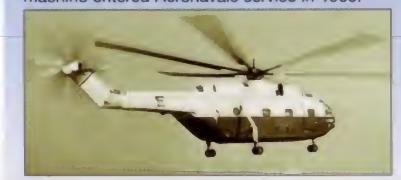
FERRY RANGE

The endurance of each type is reflected by the range figure. The values quoted are for ferry range with a maximum fuel load and no weapons or other equipment on board. Range performance is particularly important when it comes to carrier-based aircraft.

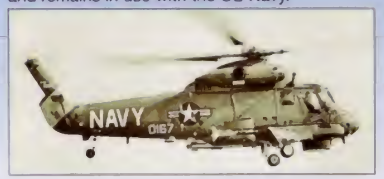


Anti-submarine helicopter designs

AÉROSPATIALE SA 321 SUPER FRELON: The SA 321G ASW variant of this three-engined machine entered Aéronavale service in 1965.



KAMAN SH-2 SEASPRITE: Derived from the UH-2, this ASW variant appeared in 1970 and remains in use with the US Navy.



WESTLAND LYNX: The first naval version of the Lynx did not fly until 1976. Widely exported, it is the Royal Navy's principal ASW machine.

SIKORSKY SH-3 SEA KING: Sikorsky's very successful S-61 design flew in 1959 and has been developed by Westland and Agusta.

MIL

MI-24 'HIND-A'

● Soviet gunship/assault helicopter ● Exported ● Afghan action

Soviet helicopter pioneer Mikhail Mil's last helicopter design, the Mi-24, has been one of the most widely used military helicopters. The original Mi-24 prototype flew in 1970, and was used with two other prototypes to establish several speed, height and climb records. Initial production aircraft were given the NATO reporting name 'Hind-A', and were operated by a three-man crew, including a flight engineer as well as a co-pilot/gunner.

▲ *On its entry into Soviet service, the Mi-24 was unique. The West had no direct equivalent, which was considered disastrous at the time. The response was to develop the dedicated AH-64 Apache, a far more effective tank-killer.*

PHOTO FILE

MIL MI-24 'HIND-A'

▲ Low-drag attributes
Cockpit glazing was designed to reduce drag and contributed to the Mi-24's excellent performance.

▲ Well armed
A variety of weapons (including anti-tank missiles, rockets and bombs) was carried on 'wings' behind the cabin. Each had a 250-kg (550-lb) capacity. The Mi-24 first saw action in Afghanistan.

▲ Inspired by HueyCobra
Mikhail Mil studied the American Bell 209 HueyCobra before proposing the Mi-24. The 'Hind' differed from the Cobra in having a troop-carrying capability.

▲ 'Hinds' in action
During the Soviet intervention in Afghanistan in the 1980s, 'Hind-As' and 'Hind-Ds' were used in the COIN role.

Museum piece ▶
Most early-model 'Hinds' are today relegated to the museums.

FACTS AND FIGURES

- Iraqi Mi-24s were credited with downing Iranian Cobra helicopters and even F-4 fighter-bombers during the Iran–Iraq War.
- An Mi-24 prototype flew for the first time in early 1970.
- A 'Hind-A' was modified to test systems for the later 'Hind-D'.
- Pre-production Mi-24s were known as 'Hind-B' in the West as they were not identified until after production 'Hind-As'.
- During the conflict in Afghanistan, Mi-24s were flown by Soviet and Afghan forces.
- As well as carrying weapons, the stub wings provide some lift.

PROFILE

Warsaw Pact armed assault chopper

Built to take troops to the thick of battlefield action, the Mi-24 gained from lessons learned by US forces in Vietnam. Big enough to carry eight troops, it was powerful and fast, and carried enough weapons to suppress hostile forces en route to the landing zone – a flying armoured personnel carrier.

Mil used the TV2-117 engines and dynamic system from the Mi-8 'Hip' so that design work could be concentrated on the weapons installation. As a result, the 'Hind-A' was in service with the Soviet forces in East Germany from 1973.

The TV2-117 engines were replaced by TV3-117s in later production aircraft, and the same powerplant was fitted to some earlier machines. 'Hind-As' with the later engine have the tail rotor repositioned on the left of the tail boom.

Although the 'Hind-A' was not exported as widely as some of the later gunship versions of the Mi-24, small numbers have served with the forces of Afghanistan (where the type saw its first action, mainly in the counterinsurgency role), Algeria, Libya and Vietnam.

The 'Hind-C' (Mi-24U) was a dedicated training version of the 'Hind-A' with dual controls but stripped of armament. It was one of these aircraft (designated 'A-10') that was used in 1975 to set eight world marks, including a number of speed records, with a female aircrew. From the mid-1970s, the redesigned 'Hind-D' replaced the A model on the production line.

Straight wings without anhedral identify this Mi-24 as a 'Hind-B' from the first production series.

Mi-24 'Hind-A'

Type: gunship/assault helicopter

Powerplant: two 1434-kW (1,923-hp) Isotov TV3-117MT turboshafts

Maximum speed: 320 km/h (199 mph)

Climb rate: 900 m/min (2,953 fpm) at sea level

Range: 750 km (466 miles)

Service ceiling: 4500 m (14,764 ft)

Weights: empty 8400 kg (18,519 lb); maximum take-off 12,500 kg (27,558 lb)

Armament: one 12.7-mm (0.5-in) machine gun and four AT-2 'Swatter' anti-tank missiles plus bombs or two rocket pods

Dimensions:

rotor diameter	17.30 m (56 ft 9 in)
length	17.51 m (57 ft 5 in)
height	6.50 m (21 ft 4 in)
rotor disc area	235.00 m² (2,530 sq ft)

MI-24 'HIND-A'

Libya was among four Soviet allies to receive the 'Hind-A', the others being Algeria, Afghanistan and Vietnam. It is believed that few, if any, 'Hind-As' remain in service.

It is believed that from the outset the 'Hind' was expected to have a dual role as both a gunship and an assault helicopter (thus replacing the Mi-8 'Hip'). However, Mi-24s have never been able to carry a full weapons load while carrying troops, and the dual role abilities of the type are limited.

Twin 1434-kW Isotov TV-3 turboshafts powered most Mi-24s, though early production batches were fitted with smaller TV-2s as installed in the Mi-8, on which the Mi-24 design was based.

Shrouded in flat plate glazing, the cockpit of the 'Hind-A' had three seats. The crew consisted of a gunner seated in the centre front, a flight engineer/co-pilot behind him to the rear, and the pilot offset to the left rear, next to the co-pilot. In the lower nose a 12.7-mm (0.5-in) machine gun was fitted in a flexible mounting.

Unlike the extensively redesigned 'Hind-D', the 'Hind-A' was only lightly armoured.

Each stub wing can carry two Falanga anti-tank missiles (known to NATO as AT-2 'Swatters') as well as four 32-round rocket pods. Various antennas on the aircraft were associated with radio equipment and defensive avionics, such as IFF (identification friend or foe).

While early production 'Hind-As' and some later 'Hind-Ds' had their tail rotors located on the starboard side of the tailfin, those on late 'Hind-As' were switched to the port side.

'Hinds' at home and abroad

■ **Mi-24 'HIND-A':** Algerian 'Hind-As' served alongside Mi-4s and Mi-8s. In 1996 the North African state continued to fly 'Hinds', although whether these were 'Hind-As' is unclear. Few export customers ordered the variant.

■ **Mi-24D 'HIND-D':** The 'Hind-D' was a major redesign of the Mi-24 intended to address the weaknesses of the 'Hind-A'. Early production examples of the new aircraft were delivered to Warsaw Pact countries, including East Germany.

■ **Mi-24P 'HIND-F':** Experience in Afghanistan led to replacing the 12.7-mm (0.5-in) nose-mounted machine gun with a twin-barrelled 30-mm (1.18-in) cannon on the Mi-24P. The USSR and GDR used this variant; the Mi-35P was an export derivative.

COMBAT DATA

MAXIMUM SPEED

As the 'Hind' was developed with new engines, a redesigned fuselage and more capable weapons, its top speed fluctuated. The first Mi-24Ds were marginally slower than the 'Hind-A', but by the time that the Mi-24P 'Hind-F' had appeared in service this had been addressed, the type having a small top speed margin over the Mi-24D 'Hind-D'.

Mi-24 'HIND-A'	320 km/h (199 mph)
Mi-24D 'HIND-D'	310 km/h (193 mph)
Mi-24P 'HIND-F'	335 km/h (208 mph)

MIL

MI-24 'HIND'

● Gunship ● Tank-buster ● Afghan war veteran

▲ *The 'Hind' was regarded with awe by NATO when it appeared in the 1970s. Now regarded as a simple machine by Western standards, it is respected for its speed, strength and massive firepower.*

The Mil Mi-24 'Hind' is the hammer of the Russian army. A veteran of battles in Afghanistan and Angola, and most recently in Chechnya, the Mi-24 is a flying armoured personnel carrier, able to deliver a squad of soldiers and cover them with suppressive fire. Armed with a cannon and powerful laser-guided anti-armour missiles, and now fitted with the latest avionics and new engines, the 'Hind' is a highly potent attack helicopter.

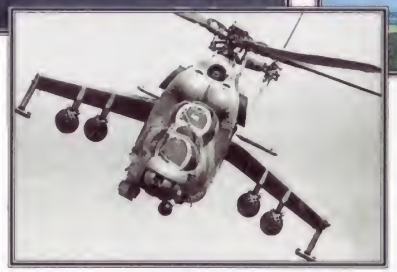
PHOTO FILE

MIL MI-24 'HIND'

▲ **Twin cannon**
The 'Hind-F' replaced the nose turret machine gun with a fixed twin-barrel 30-mm GSh cannon.

Battle wagon ▶
The 'Hind' proved its toughness in Afghanistan, where it often survived massive small-arms fire.

▲ **Tank-buster**
Standard armament in early 'Hinds' was UV-32 rocket pods and the AT-2 missile.



▲ **German 'Hind'**
The Luftwaffe has disposed of its Mi-24 fleet, acquired along with East Germany, mainly due to poor supplies of spares.

◀ **Gunfighter**
The 'Hind-D' carries the classic Mi-24 armament fit. A 12.7-mm multi-barrel gun turret shares the nose with an electro-optical guidance system to starboard and a missile guidance pod to port.

▲ **Fast mover**
The 'Hind' used its speed to advantage in attacks, acting much like a ground-attack jet fighter.

FACTS AND FIGURES

- The prototype for the Mi-24 series, fitted with a conventional cockpit, made its first flight in 1970.
- An Mi-24 set a helicopter world speed record of 368.4 km/h (228.9 mph).
- Mi-24s fought against South African troops during the Angolan war.
- Mujahideen guerrillas in Afghanistan shot down three Mi-24s at Jalalabad air base in five minutes using Stinger missiles.
- The 'Hind' is operated by more than two dozen countries.
- Two Mi-24s were flown to Pakistan by defecting Afghan air force pilots.

PROFILE

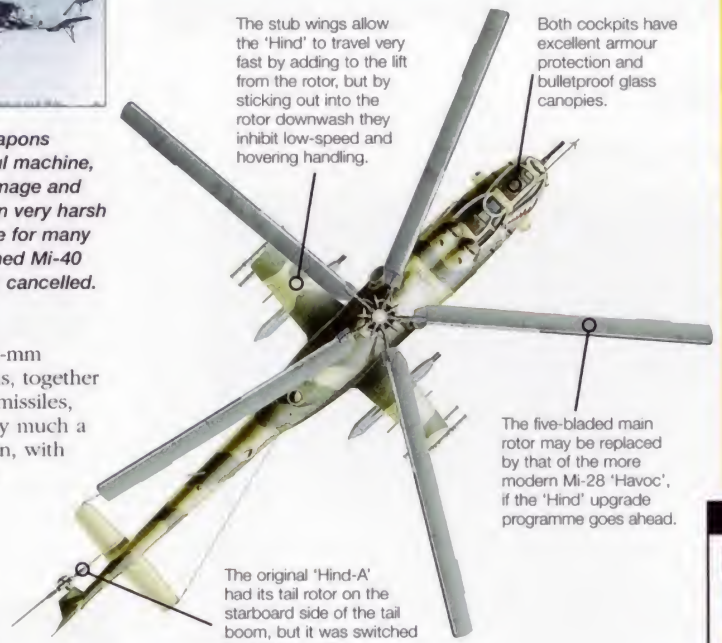
Russia's flying tank

Like most Russian weapons the 'Hind' is a powerful machine, built to take battle damage and capable of operating in very harsh conditions. It will serve for many years yet, as the planned Mi-40 replacement has been cancelled.

First seen in the West in 1974, the 'Hind' was designed to carry eight men into frontline positions and support them with air-to-ground fire. The Mi-24 is very large and fast, but it is not as agile as Western battlefield helicopters. However, aircraft such as the American AH-64 Apache are designed to engage tanks from hidden hovering positions, which calls for low-speed manoeuvrability. The 'Hind', by contrast, is a purely offensive weapon, heavily armed and armoured, and designed to advance at high speed.

Most 'Hinds' are gunships, with a stepped tandem canopy housing a weapons operator in front and a pilot higher to the rear. Either can aim the gun with a magnifying sight in a bulge under the nose, which also contains a laser tracker for missiles.

Following combat experience in Afghanistan, Mil introduced an improved 'Hind' with a twin-barrelled GSh-23L 30-mm (1.18-in) cannon. This, together with its rockets and missiles, makes the 'Hind' very much a close-support weapon, with enormous firepower.



Mi-24H 'Hind-E'

This Mi-24 'Hind-E' serves with the Polish air force's 56th squadron at Inowroclaw, armed with the 'Shturm' AT-6 laser-guided anti-tank missile.

Mi-24D 'Hind-D'

Type: battlefield helicopter

Powerplant: two 1640-kW (2,199-hp) Klimov (Isotov) TV3-117 Series III turboshafts

Maximum speed: 310 km/h (193 mph)

Maximum cruising speed: 260 km/h (162 mph)

Range: 750 km (466 mph) with internal fuel

Service ceiling: 4500 m (14,764 ft)

Weights: empty 8400 kg (18,519 lb); loaded 12,500 kg (27,558 lb)

Armament: one four-barrel JakB 12.7-mm (0.5-in) Gatling gun in chin turret; four S-8 80-mm (3.15-in) rocket pods or up to 3460 kg (7,628 lb) of rockets or missiles

Dimensions:

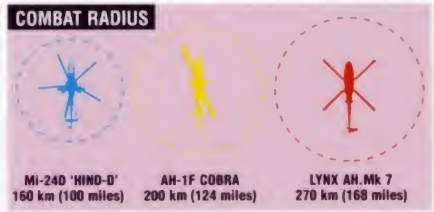
span	6.54 m (21 ft 5 in)
main rotor diameter	17.30 m (56 ft 9 in)
length	19.79 m (64 ft 11 in)
height	6.50 m (21 ft 4 in)
main rotor disc area	235.00 m² (2,530 sq ft)

COMBAT DATA

MAXIMUM CRUISING SPEED

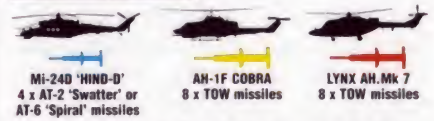
Specially prepared 'Hinds' established a number of helicopter speed records in the 1970s, and the production variant remains one of the fastest helicopters currently in service. An experimental version of Britain's Lynx has since taken the absolute helicopter speed record.

COMBAT RADIUS



The Mi-24 is a big and heavy machine, and with a full combat load its range is noticeably shorter than those of its rivals, although it can double its range by carrying drop-tanks in place of weaponry. As the 'Hind' is primarily a battlefield weapon, its lack of range is no real handicap.

ANTI-TANK WEAPONS



Although the 'Hind' carries fewer anti-tank weapons than its rivals, it should be remembered that it was not designed as an anti-tank platform. Its stub wings can be used to carry a much heavier weight of other weapons, including bombs, rockets, guns and even chemical weapons.

Gunship rivals

■ **BELL AH-1 COBRA:** This pioneering gunship helicopter introduced the now standard fighter-style cockpit, with a gunner in front and the pilot behind. Much smaller than the 'Hind', the Cobra is purely a fighting machine and has no passenger cabin.

■ **McDONNELL DOUGLAS AH-64 APACHE:** Much more manoeuvrable at low speeds than the 'Hind', the Apache is the West's premier gunship and anti-tank helicopter. Like the big Mil design, it is heavily armed and armoured.

■ **MIL Mi-28 'HAVOC':** Even more powerful than the 'Hind', the 'Havoc' dispenses with the earlier helicopter's passenger cabin. It is actively marketed by the Mil design bureau, but might not enter service with the financially strained Russian military.

MYASISHCHEV

M-4 'BISON'

● Cold War bomber ● Shuttle-carrier ● Air-to-air refueller

When it first appeared the 'Bison' terrified experts in the West, although it never fulfilled its promise to give the Soviet Union a nuclear edge: designed during the Cold War as a strategic bomber, it lacked the range to attack North America. But it was a versatile design, and as a bomber, reconnaissance platform, tanker and transport it was to serve for four decades.

▲ *The M-4 'Bison' was one of the first jet-powered strategic bombers. Known to its operators as 'Molot', or 'Sledgehammer', it was flown by both Soviet Long Range Aviation and the Soviet navy.*

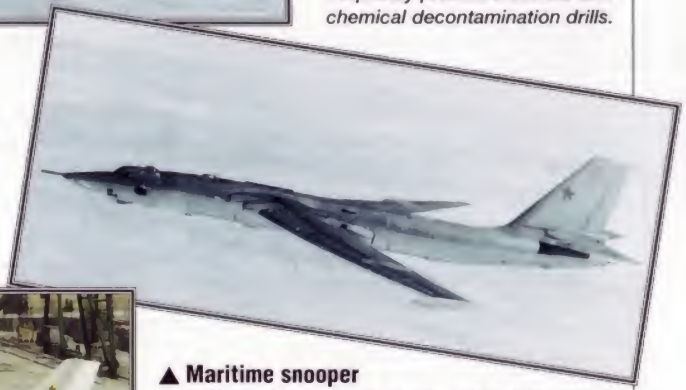
PHOTO FILE

MYASISHCHEV M-4 'BISON'

Scrub-down ▲
As it was designed as a nuclear bomber, the 'Bison's' ground crews frequently practised nuclear and chemical decontamination drills.

▲ Under armed escort
A reconnaissance 'Bison' is intercepted by RAF Lightnings as it probes NATO's air defence network.

▼ Still flying
This 'Bison' remains in service as a testbed with the Myasishchev design bureau at Zhukovski.



▲ Maritime snooper
The 'Bison-C' has a large search radar in an extended nose. It has been used mainly for maritime reconnaissance.

On display ▶
This pristine 'Bison' is seen at a Russian air display. The huge doors hanging down show the unusual position of its bicycle undercarriage. The bomb-bay is located in the fuselage between the two sets of doors.

FACTS AND FIGURES

- The huge Myasishchev bomber was revealed to the world at a fly-by over Red Square on 1 May 1954.
- On 16 September 1959 a 'Bison' lifted a 55-tonne (60.6-ton) payload to 13,121 m (43,048 ft).
- The 'Bison' has small outrigger pods to keep the wingtips clear of the runway.
- 'Bison' tankers can refuel other planes at the rate of 2250 litres (594 US gal) per minute.
- More than 40 'Bisons' were chopped into pieces in the 1980s to fulfil a strategic arms reduction agreement.
- A 'Bison' modified to carry outsize loads is known as the VM-T Atlant.

PROFILE

Multi-mission Myasishchev

The Myasishchev M-4 Bison was created in 1949 after Stalin ordered Vladimir Myasishchev to create an intercontinental bomber to carry nuclear weapons to North America. Myasishchev considered a giant, eight-engined design which would have weighed an incredible 230,000 kg (507,063 lb), but decided on the four-engined 'Bison'. He hoped that improvements in engine technology, over time, would give the bomber global reach.

The United States, which had a colossal force of 2200 bombers, feared competition when the new Myasishchev bomber was unveiled in 1954. In truth, Moscow was already focusing on intercontinental missiles, and the West's concern was exaggerated.

Although often seen as a partial failure, the 'Bison' was an excellent design, and within its limitations of range and weapons capacity performed well. It was even more successful as a long-range maritime reconnaissance craft and tanker.

Today, the 'Bison' is most visible as the civil VM-T Atlant, used to carry outsized cargoes.

'Bison' bombers were among the many strategic weapon systems scrapped in the 1980s as part of the START nuclear arms reduction process. Under the terms of the treaty, wrecked bombers were left in the open so that they were visible to American spy satellites.

M-4 'Bison-A'

Type: four-engined strategic bomber/tanker

Powerplant: four 85.32-kN (19,190-lb-thrust) Mikulin AM-3D turbojets

Maximum speed: 930 km/h (578 mph)

Range: 9400 km (5,841 miles)

Service ceiling: 14,000 m (45,932 ft)

Weights: empty 79,700 kg (175,708 lb); loaded 184,000 kg (405,651 lb)

Armament: up to 10 23-mm (0.91-in) cannon plus bombload of up to 9000 kg (19,842 lb)

Dimensions:

span	50.53 m (165 ft 9 in)
length	47.67 m (156 ft 5 in)
height	14.10 m (46 ft 3 in)
wing area	340.20 m² (3,662 sq ft)

M-4 'Bison-A'

The Myasishchev 'Bison-A' was operated as a bomber by the Long Range Aviation branch of the Soviet air force. 'Bisons' were retained in this role until the early 1980s.

The original 'Bison-A' was designed around the huge first generation of nuclear bombs which needed a massive bomb-bay to carry them.

Just like the American Boeing B-47, the 'Bison' incorporated swept-wing technology captured from German scientists at the end of World War II.

All Soviet bombers built in the 1950s and 1960s have been armed with tail guns. 'Bison' bombers are equipped with a pair of radar-directed 23-mm (0.91-in) cannon.

Today, the most important job for the 'Bison' is to carry outsize items of cargo, notably for the Russian space programme. The converted bombers carry their loads 'piggyback', and have twin fins in place of the bomber's single unit.

'Bison-A' was a strategic bomber, with a smooth nose containing radar. Later maritime reconnaissance variants had an extended nose with extensive glazing.

Underneath the nose of the 'Bison-A' was a large bombing radar. This provided accurate mapping which was fed into the weapon system.

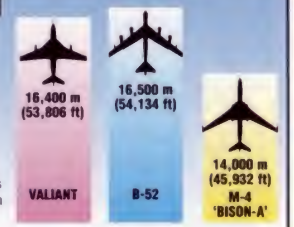
The 'Bison' is powered by four Mikulin turbojets buried in the wingroots. In their time, these were the most powerful production engines in the world.

The 'Bison's' bomb-bay is located between its bicycle-type main gears. This limited the size of weapon which could be carried, and 'Bison' bombers were never armed with the huge air-to-surface missiles carried by competing Tupolev designs.

COMBAT DATA

SERVICE CEILING

The threat of high-performance surface-to-air missiles did not exist in the 1950s, so bombers of the period were designed to operate at very high altitude. Their large, efficient wings made them as agile as fighters when flying at 12,000 m (39,370 ft) or more.

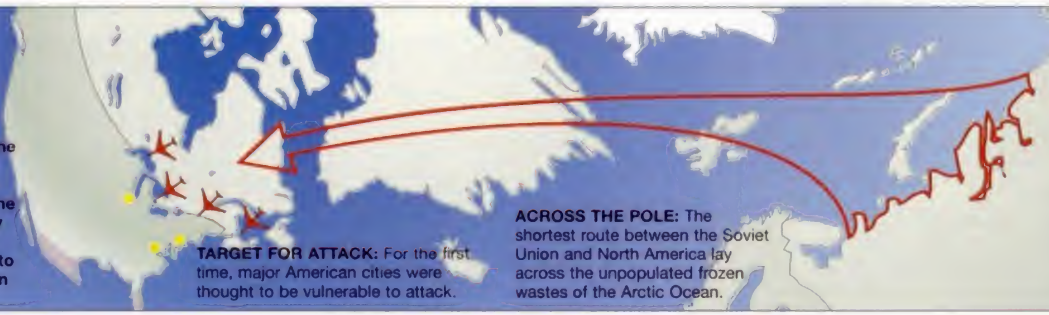


BOMBLOAD

The 'Bison' and the similar, slightly smaller British Valiant had a heavy bombload by the standards of preceding propeller-driven warplanes, but they paled into insignificance behind the immense capacity of the American B-52.

The great fear: attack across the Pole

It is hard to remember in these changed days, but the world of the 1950s seemed a very dangerous place to those who lived in it. To millions of ordinary Americans, the 'Red Menace' was personified by what was believed to be a huge force of Soviet bombers, poised to launch thermonuclear destruction at a moment's notice.



TARGET FOR ATTACK: For the first time, major American cities were thought to be vulnerable to attack.

ACROSS THE POLE: The shortest route between the Soviet Union and North America lay across the unpopulated frozen wastes of the Arctic Ocean.

THE 'BOMBER GAP': Many Western analysts believed that the Soviets had thousands of long-range bombers such as the 'Bison' poised along the northern coasts of the Soviet Union. The fear was largely imaginary – there were never more than a couple of hundred bombers in service, and their long-range capability had been seriously overestimated.

NANCHANG

A-5 'FANTAN'

● Ground attack ● Converted MiG ● Tactical fighter-bomber

▲ *The A-5 might seem crude and old-fashioned, but price is important. The aircraft is an excellent low-cost 'bomb truck' in contrast to the Pakistan air force's hi-tech F-16s.*

Based loosely on the airframe of the Chinese-built MiG-19, the Nanchang A-5 'Fantan' (alias the Q-5) is a robust, capable warplane. The 'Fantan' airframe relies largely on technology of the 1950s, but incorporates more modern electronics, Sidewinder missiles and new ejection seats to ensure combat effectiveness. Although it is hardly at the cutting edge of fighter design, the A-5 has a very low price tag and suits the needs of Third World users.

PHOTO FILE

NANCHANG A-5 'FANTAN'

▲ Chinese weapon
The 'Fantan' is offered on the export market with a range of Chinese weapons such as this short-range PL-5.

▲ Armed and dangerous
Fitted with AIM-9P Sidewinders, Pakistan's A-5s are no easy target for a fighter. The original MiG-19 was known as a very dangerous dogfighter. There is also a nuclear-capable version of the Q-5 which can carry a 20-kT weapon.

▲ Black Spiders
Operating the A-5 from the large Pakistan air force base at Peshawar in North Pakistan, No. 26 squadron is known as the 'Black Spiders'. The PAF also operates the Shenyang F-6.

▲ Home defence
China is still the most numerous user, with hundreds of A-5s in service. China plans to introduce the F.10, derived from Israel's Lavi.

Flying to fight ▶
This A-5 has 57-mm rocket pods, MATRA Magic air-to-air missiles, 100-kg (220-lb) iron bombs and a pair of underwing 760-litre (201-US gal) drop-tanks.

FACTS AND FIGURES

- More than 1000 'Fantans' have been built, including 52 for Pakistan, 40 for North Korea and 20 for Bangladesh.
- China's 'Fantans' were used in the border conflict with Vietnam in 1979.
- Although design work began in 1960, the prototype A-5 first flew on 4 June 1965.
- An extended-range version carrying fuel in the bomb-bay has about a 35 per cent greater combat radius.
- The latest A-5 uses Italian-designed avionics and has additional pylons.
- The 'Fantan' carries 2827 kg (6,232 lb) of internal fuel and up to 1178 kg (2,597 lb) in drop-tanks.

PROFILE

Ground attack at low prices

The Nanchang A-5 'Fantan' gives China a low-cost, supersonic strike aircraft, demonstrating the country's ability to improve an existing military aircraft.

Although the A-5 is based on the proven MiG-19, Chinese designers created a new, stretched fuselage, an internal bomb-bay and a pointed nose. With work beginning in the early 1960s the 'Fantan' was designed, tested and produced without Soviet help and has evolved into a bomber that is quite different from its Russian origins. The A-5 has less ability in a dogfight than its MiG cousin, but it carries more bombs, can fly further and is more accurate in its important duty of air-to-ground combat. The nuclear version of the 'Fantan' dropped a real atomic bomb during a test in 1970.

Export success has been considerable in the Third World due to the price tag. Pakistan's A-5s cost just $2.6 million each, about a quarter of the cost of a Jaguar or F-16A. Pakistan upgraded its A-5s with better avionics and Sidewinder missiles, and China is now offering improved versions with laser rangefinder, head-up display, an IFF (Identification Friend or Foe) system and radar-warning receiver.

The Pakistan air force A-5s have improved avionics and British Martin-Baker ejector seats.

The cannon armament is carried in the wingroots. Unlike most modern ground-attack fighters, the A-5 uses 23-mm (0.91-in) weapons with 100 rounds each.

A-5 'Fantan'

Type: single-seat ground-attack fighter

Powerplant: two Liming (LM) (previously Shenyang) Wopen-6A turbojet engines each rated at 29.42 kN (6,617 lb thrust) dry and 36.78 kN (8,272 lb thrust) with afterburning

Maximum speed: Mach 1.12 or 1190 km/h (739 mph) at 11,000 m (36,089 ft)

Combat radius: 400 km (249 miles) to 600 km (373 miles)

Range: 2000 km (1,243 miles)

Service ceiling: 15,850 m (52,000 ft)

Weights: empty 6375 kg (14,054 lb); maximum take-off 11,830 kg (26,081 lb)

Armament: two 23-mm (0.91-in) cannon each with 100 rounds, plus tandem pairs of pylons each capable of carrying up to 500 kg (1,100 lb) of stores

Dimensions:

span	9.68 m (31 ft 9 in)
length	15.65 m (51 ft 4 in)
height	4.33 m (14 ft 2 in)
wing area	27.95 m² (301 sq ft)

A-5 'FANTAN'

Still one of the most numerous aircraft in the People's Liberation Army Air Force, the Nanchang A-5 will probably be at least partially replaced by the F.10 fighter-bomber, derived from the IAI Lavi.

The A-5's original Chinese ejection seats are another feature which customers often replace, as they are not guaranteed below 270 m (886 ft) or above 280 km/h (174 mph).

Almost all A-5 users have their aircraft painted in a three-colour stripe camouflage paint scheme.

Like the MiG-19, the A-5 has an all-moving slab tailplane.

The main clue to the A-5's MiG-19 ancestry is the swept tail.

The A-5M is equipped with the avionics from the Italian AMX, including laser-rangefinder, Alenia head-up display and inertial navigation.

The A-5 never received a radar, despite the removal of the original nose intake allowing for this. Future aircraft, if there are any, will use this space for avionics or a rangefinder.

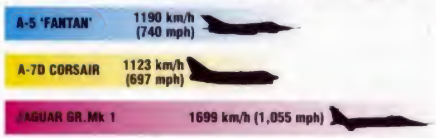
The inboard wing pylons can carry 760-litre (201-US gal) fuel tanks and the outboard pylons 400-litre (106-US gal) tanks. Air-to-air missiles are also carried on the outboard pylons.

One of the most inhibiting features of the A-5 is the Wopen turbojet that powers the aircraft. This engine is an uneconomical design and requires a major overhaul every 100 hours.

COMBAT DATA

MAXIMUM SPEED

The 'Fantan' is limited by its old technology Wopen turbojets and the increased girth of the airframe compared to the original design. Most ground-attack aircraft travel at around 800 km/h (497 mph) in combat, however, and theoretical maximum speeds are seldom reached.

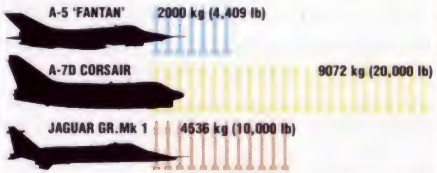


COMBAT RADIUS

Another victim of the poor engine technology is the A-5's range, which might have been improved with Western engines. Short range is generally a typical feature of second-generation MiGs, which had quite good performance.

BOMBLOAD

The 'Fantan' has quite a low bombload compared to the Jaguar and A-7, but the amount of weight carried per dollar cost of the airframe is about equal.



Many faces of the MiG-19

■ **MiG-19PM:** This MiG-19 version introduced the K-5 missile system, guided by an Izumrud radar in the nose. It could carry rocket packs.

■ **SHENYANG J-6:** China built a straight copy of the MiG-19 fighter, which is also used by Pakistan and fought in the 1965 war.

■ **S-105:** This aircraft was a Czech-built MiG-19PM which was built by Aero Vodochody between 1958 and 1963.

■ **SM-12PMU:** An experimental version, the SM-12 used a mixed powerplant of turbojets and a rocket motor which could be re-lit.

NORTH AMERICAN

FJ FURY

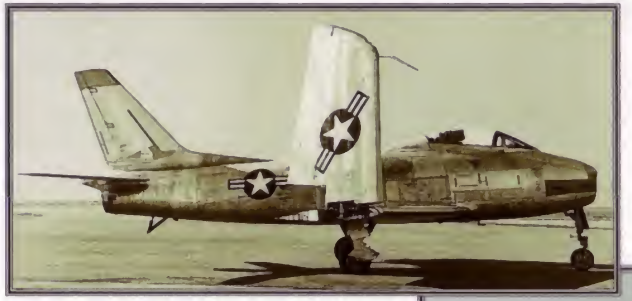
● 1950s carrier-borne jet fighter ● F-86 design derivative

▲ *Although there were initial concerns about the suitability of swept-wing designs for carrier operations, the performance of the USAF's F-86 Sabre persuaded the US Navy to adopt the FJ-2.*

Beginning life as the straight-winged FJ-1, the North American Fury became the first jet fighter to go to sea under operational conditions. After the US Navy belatedly followed the USAF in using German research data to produce swept-wing fighters, the FJ Fury was reborn as a carrier-based equivalent of the F-86 Sabre. The swept-wing Fury was one of the Navy's first fighters to carry missiles and served widely in the 1950s.

PHOTO FILE

NORTH AMERICAN **FJ FURY**



◀ 'Navalized' Sabre
The first swept-wing variant, the FJ-2, was effectively a navalized F-86F Sabre with folding wings and 20-mm (0.79-in) cannon armament.

▼ Rocket motor boost
To test a rocket installation, two FJ-4s were fitted with an AR-1 motor and nose instrumentation.

▼ Air-to-air refuelling FJ-4s
Like the FJ-3, the FJ-4B had an in-flight refuelling receptacle on the port wing and could carry 'buddy' refuelling gear.

▼ VMF-232 'Red Devils'
Marine Fighter Squadron 232's FJ-2s set a Navy-Marine flight record, flying 2558 hours in one month. Twenty-one aircraft and 52 pilots participated. The FJ-2 shared its 'slatted wing' with the F-86F Sabre.

▼ FJ-4B attack-fighter
This final Fury variant had six underwing pylons, for stores such as Bullpup air-to-surface missiles.

FACTS AND FIGURES

- After its first flight on 27 November 1946, the FJ-1 became the US Navy's first operational carrier jet.
- FJ-3Ms and FJ-4s were able to carry AAM-N-7 Sidewinder air-to-air missiles.
- Starting in January 1954, all 200 FJ-2s were delivered to Marine Corps fighter units.
- The final Fury variant, the FJ-4B, was equipped with the LABS low-altitude nuclear weapon delivery system.
- Furies remained in Naval Reserve service into the 1960s.
- In all, North American's Columbus, Ohio, plant delivered 1115 swept-wing Furies.

PROFILE

First operational jet carrier fighters

From the fat, straight-winged, dark blue FJ-1 to the sleek, swept-winged, grey and white FJ-4, the North American FJ Fury fighters of the US Navy and Marine Corps marked a decade of progress that began at the start of the jet age and continued to the brink of the supersonic era. Although the Fury never went to war, from the late 1940s to the Beirut crisis of 1958, the aircraft was armed and ready to fight if the need arose.

Thirty straight-winged FJ-1 Fury fighters were briefly the newest and fastest machines in the sky when they went aboard the carrier USS *Boxer* in 1948. Quickly overtaken by other jets (the Navy focusing on the straight-wing F9F Panther which became its standard fighter in the Korean War), the FJ-1 Fury was relegated to Reserve duty, then retired, in less than two years.

North American, meanwhile, had developed a faster, swept-wing aircraft, based on the FJ-1 and called the F-86 Sabre, for the USAF. The swept-wing FJ-2, FJ-3 and FJ-4 Fury fighters resulted from an effort to produce a navalized F-86. While the first FJ-2 was little more than a Sabre in blue paint, the FJ-3 and much improved FJ-4 missile-armed attack fighter introduced new engines and major airframe and equipment changes.

Above: The first Fury, XFJ-1 39053, took to the air on 27 November 1946. The 30 FJ-1s were destined to be 'fighter familiarization' aircraft, rather than combat types.

Above: FJ-3s of VF-21 Squadron fly over the USS Forrestal. The last FJ-3s were delivered in 1956, a year after this new carrier was commissioned.

FJ-4 Fury

Type: single-seat carrier-based fighter

Powerplant: one 34.25-kN (7,703-lb-thrust) Wright J65-W-16A turbojet engine

Maximum speed: 1094 km/h (680 mph) at sea level

Endurance: 859 km/h

Initial climb rate: 2334 m/min (7,657 fpm)

Range: 3250 km (2,019 miles)

Combat ceiling: 14,265 m (46,801 ft)

Weights: empty 5991 kg (13,208 lb); loaded 10,750 kg (23,700 lb)

Armament: four 20-mm cannon, plus up to 1360 kg (2,998 lb) of weapons (including bombs, rockets or four AAM-N-7 Sidewinder air-to-air missiles) on four wing pylons

Dimensions:

span	11.91 m (39 ft 1 in)
length	11.07 m (36 ft 4 in)
height	4.24 m (13 ft 11 in)
wing area	31.49 m² (339 sq ft)

FJ-1 Fury

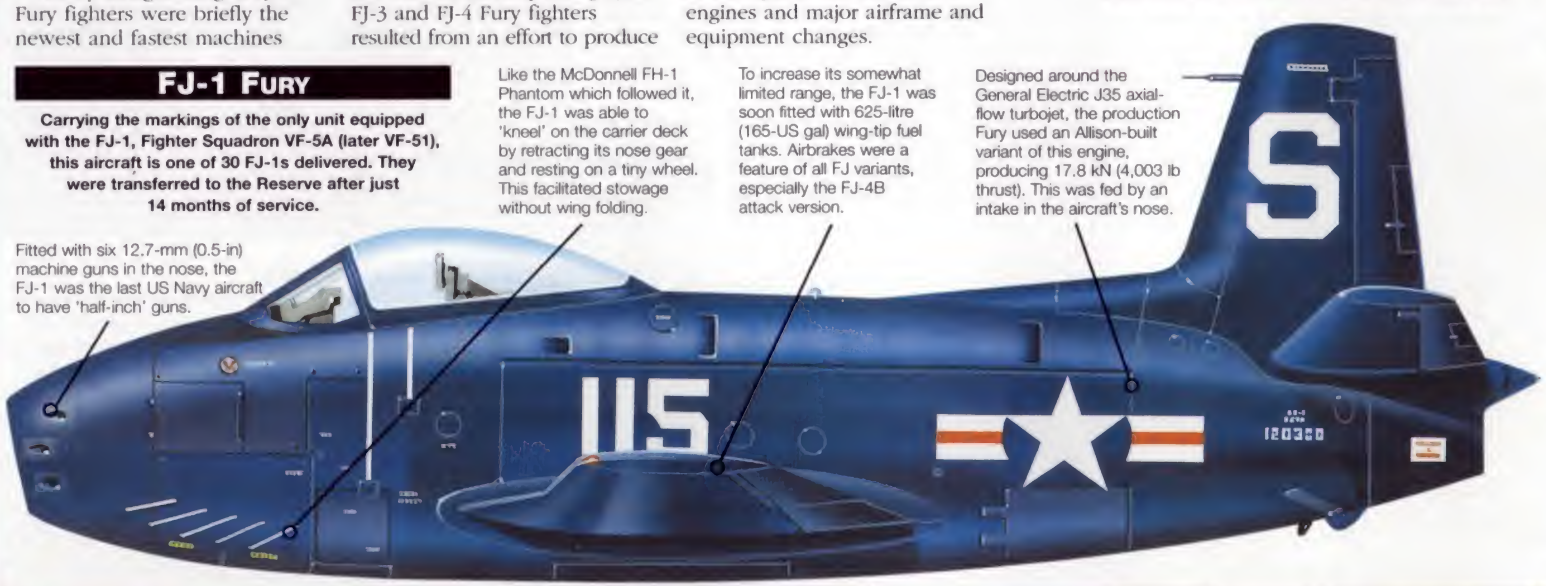
Carrying the markings of the only unit equipped with the FJ-1, Fighter Squadron VF-5A (later VF-51), this aircraft is one of 30 FJ-1s delivered. They were transferred to the Reserve after just 14 months of service.

Like the McDonnell FH-1 Phantom which followed it, the FJ-1 was able to 'kneel' on the carrier deck by retracting its nose gear and resting on a tiny wheel. This facilitated stowage without wing folding.

To increase its somewhat limited range, the FJ-1 was soon fitted with 625-litre (165-US gal) wing-tip fuel tanks. Airbrakes were a feature of all FJ variants, especially the FJ-4B attack version.

Designed around the General Electric J35 axial-flow turbojet, the production Fury used an Allison-built variant of this engine, producing 17.8 kN (4,003 lb thrust). This was fed by an intake in the aircraft's nose.

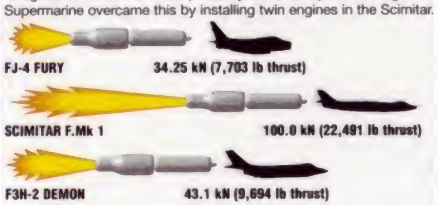
Fitted with six 12.7-mm (0.5-in) machine guns in the nose, the FJ-1 was the last US Navy aircraft to have 'half-inch' guns.



ACTION DATA

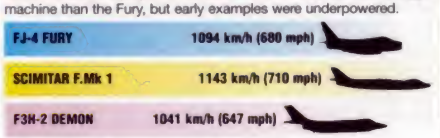
THRUST

Although the afterburner had been introduced, naval jet fighter design in the 1950s was hampered by the lack of powerful engines. Supermarine overcame this by installing twin engines in the Scimitar.



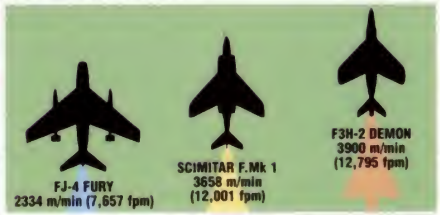
MAXIMUM SPEED

Even though it had twin engines, the Scimitar was a heavy aircraft which limited its top speed. The McDonnell F3H Demon was a bigger machine than the Fury, but early examples were underpowered.



CLIMB RATE

Advances in wing and engine design and improved power-to-weight ratios were reflected in better climb rates of aircraft such as the Scimitar and the Demon.



US Navy aircraft from North American

■ **SNJ TEXAN:** Like the USAAF and Allied air forces, the US Navy took delivery of hundreds of Texans for pilot training from the late 1930s.

■ **AJ SAVAGE:** Ordered as a carrier-borne nuclear strike aircraft in 1946, the AJ had two piston engines and a small turbojet in the tail.

■ **T2J BUCKEYE:** The T2J entered service as the US Navy's all-purpose trainer, in single- and twin-engined forms, from 1959.

■ **A3J VIGILANTE:** Known as the A-5 from 1962, the A3J entered service as an all-weather attack aircraft in 1961 aboard USS *Enterprise*.

NORTH AMERICAN

F-86 SABRE

● Jet vs jet combat ● US vs Soviet pilots ● Multiple kills

▲ *Even in its initial form the F-86 was a match for the Soviet-flown MiG-15s. However, improved Sabres, such as the F-86E, soon dominated when the MiGs were flown by less experienced pilots.*

Together, the F-86 Sabre and MiG-15 brought swept wings and the sonic bang to modern warfare. Developed at the same time, both aircraft were just supersonic in a dive. In 1950 the Sabre was rushed to Korea to confront the MiG in a new kind of combat with closing speeds and performance never before experienced. High over the Yalu River, Sabres and MiGs tested each other in the biggest jet-versus-jet battles in history.

PHOTO FILE

NORTH AMERICAN F-86 SABRE

▲ Dixon's tail
Lieutenant Colonel Dixon was about to fire at a MiG-15, when his F-86F was hit by anti-aircraft artillery fire.

▲ MiG testing
Senior Lieutenant Kum Suk No took his MiG-15 to the Americans when he landed at Kimpo airfield as a defector. The MiG was first tested at Kadena in Japan by Chuck Yeager and later at Wright-Patterson in the USA, where it survives at the USAF museum.

▲ Victorious Sabre
This rare photograph was taken by the gun camera of an F-86 which had just peppered the MiG with 12.7-mm (0.5-in) machine-gun fire. The pilot ejected seconds later, leaving the MiG-15 to its fiery fate.

▲ Improved interceptor
As the F-86A was entering combat in Korea, North American was putting the F-86E into production. This improved model was superior to the MiG-15.

US air power for the United Nations ▶
Large numbers of US aircraft were committed to the United Nations' effort in Korea. This photograph shows several combat-ready F-86 Sabres.

FACTS AND FIGURES

- Design of both the Sabre and the MiG-15 was made possible by German swept-wing research.
- The first Sabres arrived at Kimpo airfield, near Seoul, Korea, in December 1950.
- Captain Joseph P. McConnell, a top Sabre ace, scored 16 victories in Korea.
- Late-model Sabres had a redesigned wing, known as the 6-3 wing, which improved manoeuvrability in combat.
- One downed F-86 was test-flown by the Soviets near Moscow.
- Total production of all versions of the Sabre exceeded 9000 aircraft.

PROFILE

Swept wings over Korea

America's Sabre pilots were well trained, confident and ready to face the MiG-15. Many of the pilots had flown combat in World War II, just five years earlier, and in 1950 they introduced the first US swept-wing jet into battle.

Mikoyan-Gurevich had produced an aircraft more than worthy of the Sabre's challenge, however, and the MiG-15 was capable of flying higher than the F-86 and was armed with cannon rather than the Sabre's six machine guns. Both fighters were fast and manoeuvrable. Ultimately, the result of each aerial battle was largely determined by the pilots.

Unknown to the Americans at the time, the first MiGs were flown by experienced Soviet pilots. It was only later, when Chinese and North Korean pilots took over, that the better training of the US pilots won through. As the Sabre gained the upper hand, the Americans claimed that 15 MiGs were shot down for every F-86 lost. After the war research revealed that the correct figure was actually seven to one, but this was still a remarkable statistic in the history of air-to-air combat.

A pair of Sabres takes off in search of MiGs. Many missions involved flying top cover for US fighter-bombers.

Low-level manoeuvrability was improved on the F-86A and E, with the use of leading-edge slats. These were a disadvantage at altitude, however, and they were deleted on the F-86F.

North American, in common with Mikoyan-Gurevich, relied on the work of German aeronautical engineers to produce the swept wings for its aircraft.

On the F-86E, the tailplane of the F-86A was replaced by an all-moving surface, which included larger, power-boosted elevators. The entire control system was given improved 'feel'.

Guided missile development was some way behind the technology of the jet aircraft and both the F-86 and MiG-15s were gun-armed in Korea.

F-86E SABRE

***Elenore 'E'* was flown by Major William T. Whisner of the 25th Fighter Interceptor Squadron, 51st Fighter Interceptor Wing.**

North American developed and built the ejection seat used in the F-86. Such escape systems were vital at the high speeds reached by the new jets.

All Sabres flying over Korea had followed the instructions of the Far East Air Force (FEAF) by the summer of 1952, with the adoption of yellow theatre markings.

Both the F-86A and E models were powered by the General Electric J47-GE-13 turbojet. The F-86F used the J47-GE-27, which improved time taken to reach 9144 m (30,000 ft) by almost one minute and added an extra 244 m (800 ft) to its maximum altitude.

Sabres always flew with drop-tanks. The extra fuel allowed a transit to North Korea and increased loiter time in the combat zone. The tanks were jettisoned as soon as MiGs were sighted.

F-86E Sabre

Type: single-seat fighter and fighter-bomber

Powerplant: one 23.13-kN (5,202-lb-thrust) General Electric J47-GE-13 turbojet engine

Maximum speed: 1086 km/h (675 mph) at 762 m (2,500 ft)

Initial climb rate: 2326 m/min (7,631 fpm)

Range: 1263 km (785 miles)

Service ceiling: 14,722 m (48,300 ft)

Weights: empty 4760 kg (10,494 lb); maximum take-off 4987 kg (10,994 lb)

Armament: six 12.7-mm (0.5-in) machine guns with 267 rounds per gun; provision for two 454-kg (1,000-lb) bombs or 16 127-mm (5-in) rocket projectiles

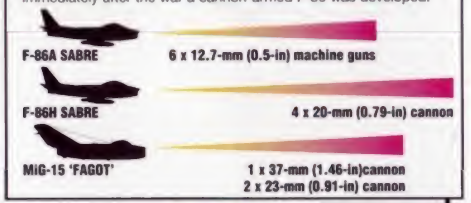
Dimensions:

span	11.31 m (37 ft 1in)
length	11.43 m (37 ft 6 in)
height	4.47 m (14 ft 8 in)
wing area	26.76 m² (288 sq ft)

COMBAT DATA

ARMAMENT

With its cannon armament the MiG-15 had much greater firepower than the Sabre. Improvements in power and controllability, together with superior training, allowed the US pilots to overcome this, but immediately after the war a cannon-armed F-86 was developed.



MiG-killing over Korea

LAUNCH: United Nation bases were scattered around the coast of Korea, but the base closest to the action was Kimpo, just south of the 38th Parallel.

TARGET MiG: With its good manoeuvrability, altitude advantage and heavy weaponry, the MiG-15 in Russian hands was a difficult opponent. The advantage was never clear-cut between the MiG and Sabre.

MiG IN SIGHT: This MiG is in a desperate situation, with the 'pipper' of an F-86's gunsight closing in on its tail. A simple radar allowed gun-ranging.

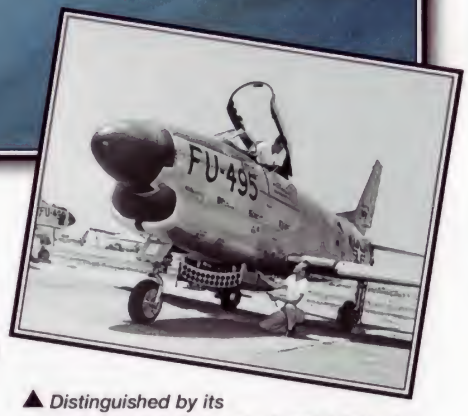
FIREBALL: Even though the F-86's armament was not as powerful as that of the MiG-15, a well-placed burst from its six machine guns could have a devastating effect on the Russian plane. Hits to the rear fuselage were most likely to damage vital systems.

COMBAT ZONE: Only Sabres were allowed into the area known as 'MiG Alley'; other United Nation aircraft, even the jets, were considered to be too vulnerable. In response to this decision, the Soviets moved more MiGs into North Korea, making 'MiG Alley' a hotbed of air combat.

NORTH AMERICAN

F-86D/H/K SABRE DOG

● All-weather operations ● Interceptor ● Ground attack



▲ *Distinguished by its nose-mounted radome, the F-86D/H/K series turned the basic F-86 into a specialized and highly competent all-weather interceptor and attack aircraft.*

To defend North America, the USAF worked frantically in the 1950s to develop fighter-interceptors which were able to fly and fight in any weather. As an interim measure, experts took the F-86 Sabre design from the Korean War and added radar and air-to-air rockets. This produced the F-86D Sabre Dog – an all-weather interceptor with a one-man crew. The Sabre Dog was developed into the F-86K/L by the addition of cannon armament.

PHOTO FILE

NORTH AMERICAN F-86D/H/K SABRE DOG

German Sabre Dog ▶
The F-86K, which was supplied to European air forces, was produced by replacing the rockets of the F-86D with four 20-mm cannon.

◀ Defending Southeast Asia
A number of F-86Ds were delivered to the air force of the then newly established Philippine republic, bolstering regional air defence.

NATO fighter ▶
Analogous to the F-16 programme, the F-86K became the standard fighter of several NATO air arms in Europe. It was paid for by the USAF.

Rocket pack
A retractable rocket-launching pack was fitted to the belly of the F-86D for air-to-air work.

European Sidewinders ▶
As new systems became available these were combined with the already advanced, complex avionics of the F-86D and K. New weapons included the AIM-9 Sidewinder, seen here on an F-86K, which was later licence-built in Europe.

FACTS AND FIGURES

- Production of Sabre Dog interceptors totalled 2626, including 120 export versions armed with cannon.
- An additional 121 aircraft were built for NATO use by Fiat in Italy.
- The Sabre Dog prototype first flew on 22 December 1949.
- In July 1952 mechanical faults were resolved in a modification programme called Project Pull Out.
- The F-86D's main flaw was a tendency for a sudden violent pitch downwards.
- A few Sabre Dogs were exported to Japan, South Korea and Thailand.

PROFILE

Developing the Sabre

The Sabre Dog interceptor version of the immortal North American F-86 Sabre was equipped with a distinctive nose radar unit and was flown by a pilot who was also tasked with the duties usually performed by a radar operator.

When approaching bombers were spotted on radar, an F-86D pilot was expected to rush to his aircraft and to get aloft within three minutes. He then followed instructions from a ground-control operator, who directed him to the bomber. In the later F-86L version, this process of scrambling and engaging enemy bombers was largely automated. Once within a short distance of the bombers, the pilot was expected to 'paint' them on his own radar and to attack them at a 90° angle with rocket projectiles. The export version of this interceptor was a much-simplified warplane and was armed with cannon, but it had the same task of tracking down and destroying enemy bombers.

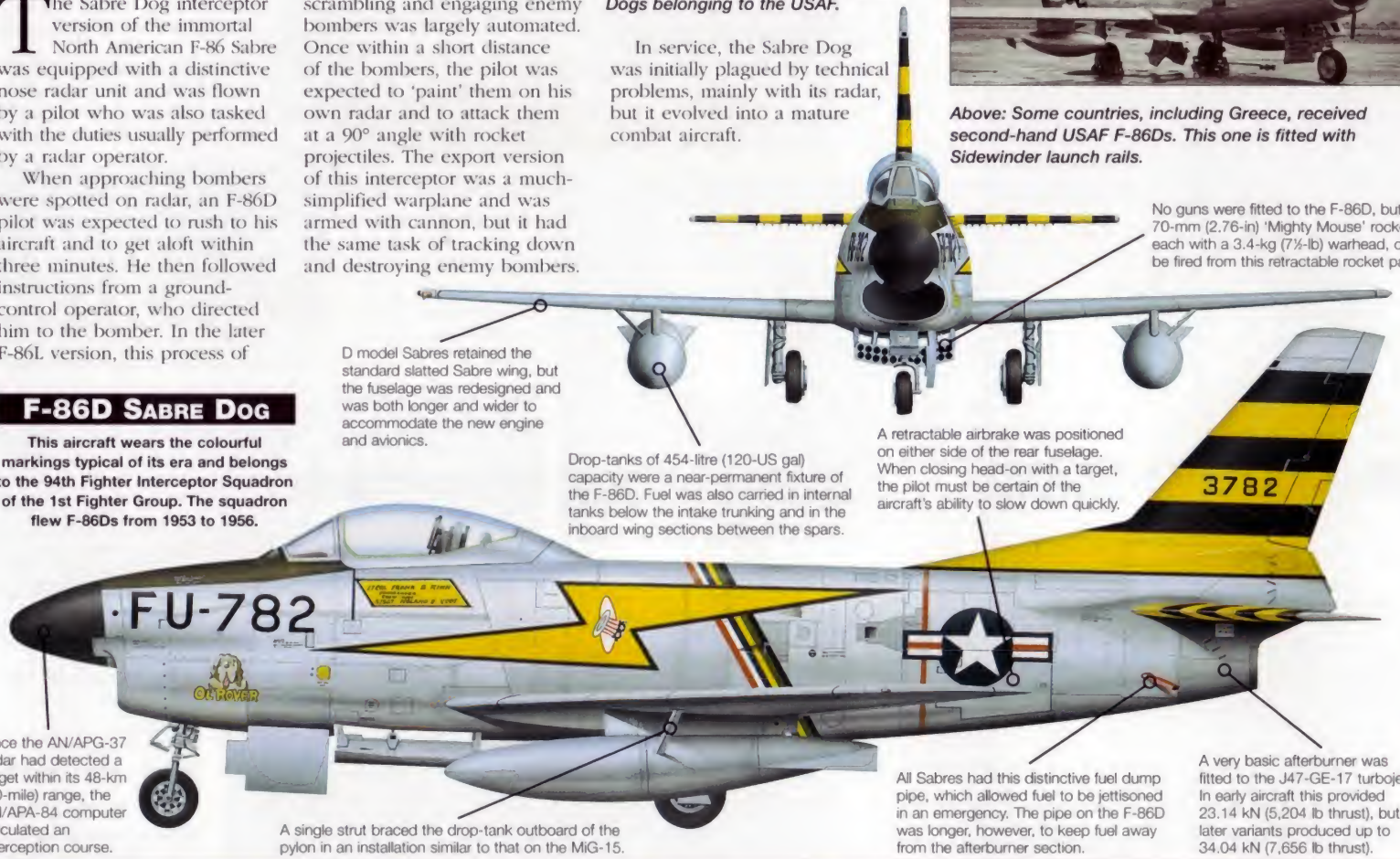
Above: Seen high over Mount Fuji, Japan, this F-86D typifies the Sabre Dogs belonging to the USAF.

In service, the Sabre Dog was initially plagued by technical problems, mainly with its radar, but it evolved into a mature combat aircraft.

Above: Some countries, including Greece, received second-hand USAF F-86Ds. This one is fitted with Sidewinder launch rails.

F-86D SABRE DOG

This aircraft wears the colourful markings typical of its era and belongs to the 94th Fighter Interceptor Squadron of the 1st Fighter Group. The squadron flew F-86Ds from 1953 to 1956.



No guns were fitted to the F-86D, but 24 70-mm (2.76-in) 'Mighty Mouse' rockets, each with a 3.4-kg (7½-lb) warhead, could be fired from this retractable rocket pack.

D model Sabres retained the standard slatted Sabre wing, but the fuselage was redesigned and was both longer and wider to accommodate the new engine and avionics.

Drop-tanks of 454-litre (120-US gal) capacity were a near-permanent fixture of the F-86D. Fuel was also carried in internal tanks below the intake trunking and in the inboard wing sections between the spars.

A retractable airbrake was positioned on either side of the rear fuselage. When closing head-on with a target, the pilot must be certain of the aircraft's ability to slow down quickly.

Once the AN/APG-37 radar had detected a target within its 48-km (30-mile) range, the AN/APA-84 computer calculated an interception course.

A single strut braced the drop-tank outboard of the pylon in an installation similar to that on the MiG-15.

All Sabres had this distinctive fuel dump pipe, which allowed fuel to be jettisoned in an emergency. The pipe on the F-86D was longer, however, to keep fuel away from the afterburner section.

A very basic afterburner was fitted to the J47-GE-17 turbojet. In early aircraft this provided 23.14 kN (5,204 lb thrust), but later variants produced up to 34.04 kN (7,656 lb thrust).

F-86D Sabre Dog

Type: single-seat all-weather interceptor

Powerplant: one 33.4-kN (7,512-lb-thrust) General Electric J47-GE-17B or J47-GE-33 turbojet with afterburning

Maximum speed: 1138 km/h (707 mph) at sea level

Range: 1344 km (835 miles)

Service ceiling: 16,640 m (54,593 ft)

Weights: empty 5656 kg (12,469 lb); maximum take-off 7756 kg (17,099 lb)

Armament: 24 70-mm (2.76-in) 'Mighty Mouse' folding-fin aircraft rockets (FFAR) or (F-86K only) four 20-mm (0.79-in) cannon

Dimensions:

span	11.30 m (37 ft 1 in)
length	12.29 m (40 ft 4 in)
height	4.57 m (15 ft)
wing area	27.76 m² (299 sq ft)

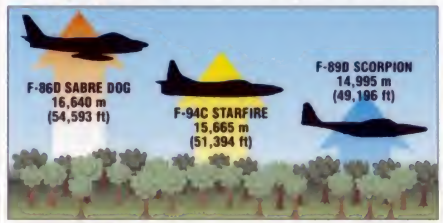
COMBAT DATA

RANGE

A comparison of contemporary American all-weather interceptors reveals their complementary nature. The F-94C Starfire covers the middle ground between the large, heavily armed F-89D, providing long-range defence, and the shorter ranged but much higher performing F-86D.

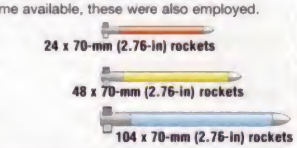
SERVICE CEILING

All three aircraft provided air defence of the USA, and any aircraft making an attack would have done so from high altitude. Armed only with rockets, an interceptor would be forced to get very close to the target so altitude performance was of great importance.



ARMAMENT

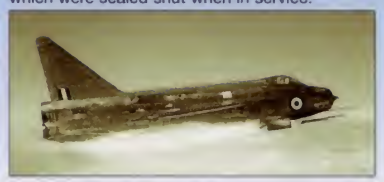
The primary armament was the unguided rocket, fired from retractable launchers, batteries in the aircraft nose or wing pods. As the first guided air-to-air missiles, such as the AIM-9 and Hughes Falcon, became available, these were also employed.



Rocket-armed interceptors

■ **DE HAVILLAND SEA VIXEN:** Retractable launching batteries were built into the forward fuselage of the Sea Vixen, but were rarely used.

■ **ENGLISH ELECTRIC (BAC) LIGHTNING:** Provision was made for two retractable launchers, which were sealed shut when in service.



■ **LOCKHEED F-94C STARFIRE:** Each wing-tip pod held 12 rockets and a further 24 were carried in a ring of launchers around the nose.

■ **NORTHROP F-89D SCORPION:** Permanently attached wingtip pods held the Scorpion's powerful 104-rocket armament.

NORTH AMERICAN

F-100 SUPER SABRE

● USAF's first supersonic jet ● Zero-length launches ● War service

▲ *In its heyday, the F-100 equipped 16 full USAF wings, assuming a fighter-bomber role as faster interceptor types became available. It was the USAF's first fighter to reach Mach 1 in level flight.*

Sabre 45 was the name given to North American's private efforts to produce a supersonic development of its highly successful F-86 Sabre. The name referred to the wing's 45° of sweep. This programme proved not to be as easy as envisaged, but after early problems the final product was to prove its worth, especially in Vietnam. Although it always had an accident rate higher than other types, the Super Sabre had plenty of fans among aviators.

PHOTO FILE

NORTH AMERICAN F-100 SUPER SABRE

◀ Zero-length launches
The final F-100Ds could be 'zero-length launched' from atom bomb-proof shelters using a 667-kN (150,017-lb-thrust) rocket booster.

▼ Two-seat combat trainer
An F-100C was modified as a two-seat TF-100C, the prototype for the F-100F; 339 were built.

◀ 'Thunderbirds'
The first F-100C fighter-bomber flew in September 1955. In all, 476 were built, some equipping the USAF's display team.

▼ Short-tail F-100A
The first 70 production F-100As had shorter fins, which caused roll control problems.

▲ Armée de l'Air 'Hun'
Super Sabres were exported to France, Taiwan, Denmark and Turkey, the last named being the final operator until the late 1980s. Ex-USAF examples are used as QF-100 target drones.

FACTS AND FIGURES

- Test pilot George Welch likened the effect of the first YF-100's afterburner to 'a kick from a well-fed mule'.
- More than 200 surplus F-100s were converted into QF-100 target drones.
- Between mid-1956 and mid-1970, more than 500 F-100Ds were lost in accidents.
- On 20 August 1955 a USAF colonel in an F-100C set the first world speed record over Mach 1 – 1323.03 km/h (822.09 mph).
- The first F-100 model flown overseas was the F-100C, using in-flight refuelling.
- USAF F-100s were deployed overseas to Germany and Japan in 1956.

PROFILE

First of the 'Century' fighters

Considering it suffered from so many inherent problems, including landing characteristics described by a pilot with 2000 hours on the type as 'a controlled crash', the F-100 is remembered with respect and some affection by a generation of aviators.

Its good features were viceless handling, a robust airframe and reliable systems. The Super Sabre was the latest product from the North American team that produced P-51 Mustangs and F-86 Sabres.

Attempts to build a supersonic Sabre had been killed by the limitations of its wing and engine. The latter problem was solved by Pratt & Whitney's JT3 (J57) turbojet, so, with USAF agreement, a new aircraft was designed. After the 24 April 1953 first flight, the Super Sabre went into production for the USAF as the F-100A day-fighter. However, a fatal crash caused by handling problems brought groundings and delays. A taller tail fin and longer wings were the solution.

Above: Demonstrating the afterburner fitted to its Pratt & Whitney J57 engine, this F-100 starts its take-off run. Poor fuel economy resulted in the aircraft carrying underwing fuel tanks.

From 1954, the F-100C fighter-bomber was built, and it was this and the much-improved D-model that were built in the biggest numbers – 1750 in all.

Above: Bullpup air-to-surface missiles could be fired from a number of modified F-100Ds. Some D-model 'Huns' were also wired to carry Sidewinder air-to-air missiles.

F-100D Super Sabre

In the markings of the 481st TFS, this 'Hun' (as it was nicknamed – short for 'Hundred') was the personal aircraft of World War II P-47 ace Lieutenant Colonel Hal Comstock. It carries the skull insignia that adorned his P-47, and seven German kill markings.

A key feature of the F-100D was the redesigned wing. This had a kinked trailing edge incorporating broad, slotted landing flaps. These were much needed and appreciated by pilots used to the high-speed landing run of the F-100C. Extra internal tankage was provided. D-models were built at North American's Inglewood, California, and Columbus, Ohio, factories.

The most obvious identification feature of the D-model was its taller vertical tail, introduced to improve handling. This incorporated a deeper fairing for the fuel dump pipe (later used to mount the radar warning receiver antenna).

An afterburning version of Pratt & Whitney's J57 turbojet was fitted to the 'Hun'. This engine had already flown in such types as the B-52 bomber and the Navy's A-3 Skywarrior and F-8 Crusader, the latter also using an afterburning variant.

This aircraft represents an F-100 in the early years of USAF involvement in the Vietnam War. Camouflage was later applied to all tactical aircraft in Southeast Asia. Note the bomb mission symbols painted on the nose.

For ground-strafing and self-protection, four M39 20-mm (0.79-in) cannon were fitted in the nose of the F-100D. Two AIM-9 Sidewinder air-to-air missiles were also fitted on occasions. Air-to-ground ordnance totalling over three tonnes could be carried, including napalm, bombs, rockets and Bullpup missiles.

External fuel tanks, such as the 1268-litre (335-US gal) examples fitted to this aircraft, were necessary to give the Super Sabre an acceptable range figure. An in-flight refuelling probe could also be fitted under the right wing.

F-100D Super Sabre

Type: single-seat fighter-bomber

Powerplant: one 75.4-kN (16,958-lb-thrust) Pratt & Whitney J57-P-21A afterburning turbojet

Maximum speed: 1436 km/h (892 mph) at altitude

Initial climb rate: 5045 m/min (16,552 fpm) (clean)

Range: 2494 km (1,550 miles) with two drop-tanks

Service ceiling: 14,020 m (45,997 ft)

Weights: empty 9526 kg (21,000 lb); maximum take-off 15,800 kg (34,833 lb)

Armament: four M-39E 20-mm (0.79-in) cannon plus up to 3402 kg (7,500 lb) of external stores including bombs, napalm tanks, rockets and missiles

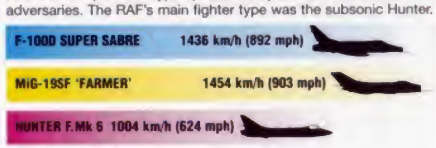
Dimensions:

span	11.82 m (38 ft 9 in)
length	14.36 m (47 ft 1 in)
height	4.94 m (16 ft 2 in)
wing area	35.77 m² (385 sq ft)

COMBAT DATA

MAXIMUM SPEED

The F-100 and MiG-19 faced each other across the Iron Curtain as the first supersonic types produced by the chief Cold War adversaries. The RAF's main fighter type was the subsonic Hunter.



ARMAMENT

Cannon armament was the primary means of air-to-air defence as these types were introduced. Missiles were still in their infancy. The F-100 had a prodigious bombload capacity.

RANGE

The Hunter had a good range performance compared to the other, faster types. All three needed to carry external fuel tanks for anything but the shortest sorties.

Sabre/Super Sabre family

FJ FURY: NA's first jet fighter was the US Navy's straight-winged Fury, which served as the basis for a swept-wing version and the F-86.

F-86 SABRE: The USAF's first swept-wing jet fighter, the Sabre was to see extensive service in the Korean War and served until 1965.

YF-93: Initially designated F-86C, the F-93 had an afterburning engine, but was hampered by the limitations of the Sabre wing design.

YF-107A: An all-weather interceptor/fighter-bomber F-100 development, initially known as the F-100B, the F-107 lost out to the F-105.

NORTHROP

F-89 SCORPION

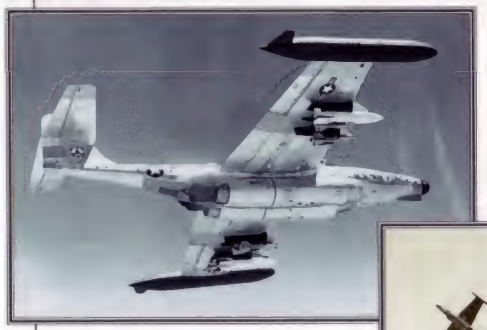
● All-weather interceptor ● North American defender ● Nuclear-capable

▲ *Problems with the F-102 Delta Dagger prolonged the service career of the Scorpion. The final variants were much improved and served on faithfully into the 1960s.*

Defending the icy wastes of the North American frontier, the much-maligned F-89 Scorpion was developed in the late 1940s and eventually soldiered on until 1969. Armed with Mighty Mouse collision-course rockets, the two-seat F-89D Scorpion interceptor provided protection against Soviet intrusion from Iceland to Alaska. Half a dozen production versions served the USAF, culminating in the definitive F-89J.

PHOTO FILE

NORTHROP F-89 SCORPION



NORAD▶ service

During the 1950s, the F-89 played a pivotal role within NORAD, the North American Air Defense system.

◀ Rapid deployment

Scorpion missions were planned throughout by Air Force GCI (Ground Control Intercept) teams. Ground-based radars each covered 1600-km (994-mile) swathes.

▲ Long-range missions

Out-and-out interceptors, unlike the contemporary F-94, the Scorpions usually operated in pairs. For northern operations, F-89s carried large Dayglo orange panels on tail, wings and tanks.

▼ Weapons upgrade

To maintain an edge over ever-improving Soviet bombers, the F-89's weapons progressed from nose-mounted cannon to a fully integrated missile system.

▲ Bomber attack

For destroying Soviet bomber formations over North America, the F-89D carried unguided rockets.

Cold War interceptor ▶

With a full weapons and fuel load, the F-89 could only just get airborne, even with the use of afterburning.

FACTS AND FIGURES

- The trailing-edge decelerons were very effective; when they deployed by mistake on one F-89 it literally fell from the sky.
- On training missions, the F-89 would regularly fly against the Lockheed T-33.
- The XF-89E was a testbed for the Allison J71 engine which later powered the B-66.
- Alaska-based aircraft would fly 1200 km (746 miles) nonstop to Edmonton, Canada, then on to Palmdale, California, for servicing.
- F-89s of the 57th FIS were tasked with the air defence of Iceland.
- In 1961 all Scorpions were relegated to Air National Guard use from the USAF.

PROFILE

Fighter with a sting

A frontline interceptor between 1954 and 1961, the F-89D was frequently scrambled to investigate intruders. This main production variant dispensed with the six 20-mm (0.79-in) cannon of previous models, in favour of an all-rocket armament.

One hit from a rocket was sufficient to take down a slow-moving bomber, and the pilot could select several firing options. Most potently, all 104 rockets could be released in just under four-tenths of a second. Usually flying in pairs, Scorpions had a considerable range, boosted when the sixteen 127-mm (5-in) underwing rockets were replaced with drop-tanks. At the heart of the F-89D's avionics package was the Hughes E-6 fire-control system, linked to the advanced AN/APA-84 computer.

During its heyday, the F-89D flew from bases in Canada, Iceland and the United States. Life for the crews was far from easy – flying under extreme conditions and aware that at any moment the air-base klaxon could sound, signalling a Soviet bomber assault from the north.

Below: Although possessing a good endurance and potent weapons load, the sluggish Scorpion was disliked by day-fighter pilots. The F-89Ds pictured carry underwing tanks for increased range.

Above: As a dedicated bomber destroyer, the original weapons fit for the F-89 was 104 unguided rockets housed in wing-tip pods. Good stability was needed to cope with the buffet created on launching.

F-89D Scorpion

Type: two-seat all-weather interceptor fighter

Powerplant: two 32.03-kN (7,204-lb-thrust) Allison J35-A-41 turbojets with Solar afterburners

Maximum speed: 1024 km/h (636 mph)

Initial climb rate: 2548 m/min (8,360 fpm)

Cruising speed: 787 km/h (489 mph)

Maximum range: 2200 km (1,367 miles)

Service ceiling: 14,996 m (49,200 ft)

Weights: empty 11,428 kg (25,194 lb); maximum take-off 19,160 kg (42,241 lb)

Armament: 104 70-mm (2.76-in) folding-fin unguided rockets in two wing-tip pods

Dimensions:

span	18.19 m (59 ft 8 in)
length	16.41 m (53 ft 10 in)
height	5.36 m (17 ft 7 in)
wing area	60.39 m² (650 sq ft)

F-89D Scorpion

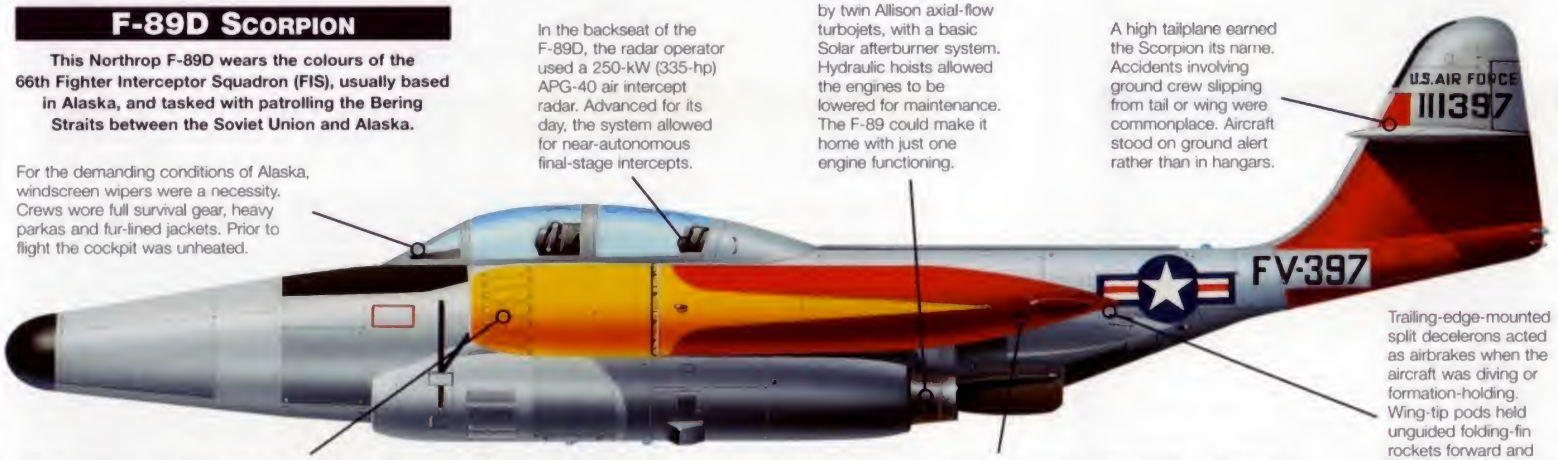
This Northrop F-89D wears the colours of the 66th Fighter Interceptor Squadron (FIS), usually based in Alaska, and tasked with patrolling the Bering Straits between the Soviet Union and Alaska.

For the demanding conditions of Alaska, windscreen wipers were a necessity. Crews wore full survival gear, heavy parkas and fur-lined jackets. Prior to flight the cockpit was unheated.

In the backseat of the F-89D, the radar operator used a 250-kW (335-hp) APG-40 air intercept radar. Advanced for its day, the system allowed for near-autonomous final-stage intercepts.

Power was provided by twin Allison axial-flow turbojets, with a basic Solar afterburner system. Hydraulic hoists allowed the engines to be lowered for maintenance. The F-89 could make it home with just one engine functioning.

A high tailplane earned the Scorpion its name. Accidents involving ground crew slipping from tail or wing were commonplace. Aircraft stood on ground alert rather than in hangars.

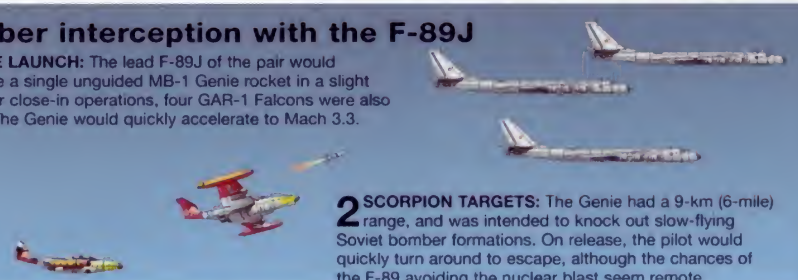


Before the 'D' model, F-89s carried six 20-mm (0.79-in) cannon in the nose. The F-89H introduced six wing-tip Falcon AAMs and 21 rockets, while the final F-89J used underwing Genie AAMs in addition to either wing-tip option of the earlier models.

A cumbersome wing made taxiing difficult, but provided great stability on the landing approach. Fuel was carried in four bulletproof tanks and 12 wing bladder tanks. Even without external tanks, the F-89D had an 11 per cent greater range than the F-89C.

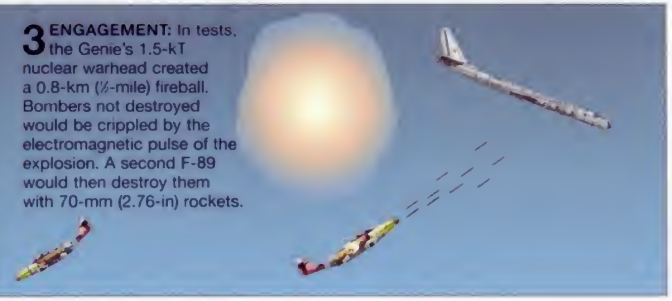
Trailing-edge-mounted split decelerons acted as airbrakes when the aircraft was diving or formation-holding. Wing-tip pods held unguided folding-fin rockets forward and fuel aft. A typical patrol mission lasted two hours 15 minutes.

Bomber interception with the F-89J



1 GENIE LAUNCH: The lead F-89J of the pair would release a single unguided MB-1 Genie rocket in a slight climb. For close-in operations, four GAR-1 Falcons were also carried. The Genie would quickly accelerate to Mach 3.3.

2 SCORPION TARGETS: The Genie had a 9-km (6-mile) range, and was intended to knock out slow-flying Soviet bomber formations. On release, the pilot would quickly turn around to escape, although the chances of the F-89 avoiding the nuclear blast seem remote.

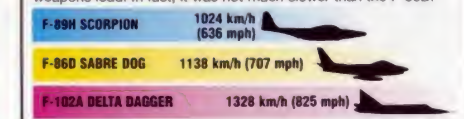


3 ENGAGEMENT: In tests, the Genie's 1.5-kT nuclear warhead created a 0.8-km (½-mile) fireball. Bombers not destroyed would be crippled by the electromagnetic pulse of the explosion. A second F-89 would then destroy them with 70-mm (2.76-in) rockets.

COMBAT DATA

MAXIMUM SPEED

While criticized for its lack of speed, the Scorpion more than made up for this with stability, good landing characteristics and a heavy weapons load. In fact, it was not much slower than the F-86D.

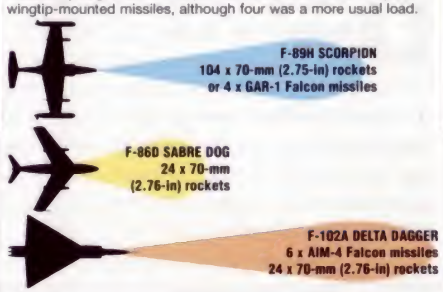


THRUST

With two turbojets, as opposed to its predecessor's single powerplant, the Scorpion had almost twice the thrust of the F-86D. Its primitive yet effective afterburner gave it a maximum thrust nearing that of its successor, the much larger Convair F-102A.

ARMAMENT

Throughout its service, the weapons system of the F-89 was continually upgraded. It was possible for the F-89H to carry six wingtip-mounted missiles, although four was a more usual load.



NORTHROP

F-5A FREEDOM FIGHTER

● Lightweight fighter ● Flown by 13 nations ● Vietnam veteran

▲ *Northrop's Freedom Fighter, as its name suggests, was a product of the Cold War. It was a means of providing an affordable yet capable aircraft for America's allies.*

Designed in the late 1950s as a lightweight fighter for supply to friendly nations as part of the US Military Assistance Program, the F-5 remains a viable combat aircraft. Although the early examples are more than 30 years old, some late production aircraft are being upgraded with modern avionics. The type's advantages include supersonic performance and the ability to carry reasonable loads while maintaining economy of operation.

PHOTO FILE

NORTHROP F-5A FREEDOM FIGHTER

▼ Scandinavian Freedom Fighter
Norway operates seven F-5As and eight F-5Bs, upgraded under PAWS (Programme for Weapons and Systems Improvements), as lead-in trainers for its new F-16s.

▲ In retirement
The Netherlands was a major F-5 operator, until it introduced the F-16.

Blooded in Vietnam ▲
Skoshi Tiger F-5s were transferred to the Vietnamese air force (VNAF) in 1967. Here, an aircraft of the 522nd Fighter Squadron is seen in its revetment at Bien Hoa Air Base.

▲ Canadian service
Known in RCAF service as the CF-116, the Freedom Fighter served in both A and D versions from Cold Lake CFB, Alberta.

Refuelled in the air ▶
From the outset, the F-5 incorporated air-to-air refuelling. These aircraft are seen being 'tanked' by a KC-135A prior to deployment in Vietnam.

FACTS AND FIGURES

- Canada operated a small number of aircraft, designated CF-116A(R), fitted with Vinten 70-mm (2.76-in) nose cameras.
- Bristol Aerospace's upgrade for the CF-116 included HOTAS controls.
- A complete F-5A upgrade, as offered by Northrop, cost $4.5 million per airframe.
- The F-5A originated from the N-156 Fang proposal for a lightweight fighter, which also led to the USAF's T-38A trainer.
- F-5 development was funded under the Mutual Defense Aid Program.
- An F-5A has an eight-minute turnaround between missions, including refuelling.

PROFILE

Lightweight fighters for America's allies

Flown for the first time in May 1963, the F-5 entered service the following year with a USAF training squadron. A dozen of the first F-5As were sent to Vietnam in 1965, where they proved able to match the USAF's frontline fighters in some missions. They served with South Vietnam throughout the 10-year war with the North.

Air forces in Europe, the Middle East, South America and Southeast Asia acquired Freedom Fighters before production switched to the uprated Northrop F-5E Tiger II. The RF-5A was adapted as a camera-equipped photo-reconnaissance version.

F-5s were also built in Canada, where Canadair produced CF-5s for the RCAF (known as CF-116s in service) and the NF-5 for the Dutch. Many ex-Canadian F-5s went to Turkey, while Greece also acquired some NF-5s.

By the mid-1980s, more than 400 of the 1100-plus Freedom Fighters built were still in service with a dozen air forces. The remaining Canadian CF-5s had been upgraded for sale, and Spain's fleet was refurbished to serve as weapons trainers.

For long-range missions, the Freedom Fighter's wing-tip missile pylons can be replaced with fuel tanks.

F-5C Freedom Fighter

Serving with the 10th Fighter Commando Squadron, F-5C 64-13332 was based at Bien Hoa Air Base, South Vietnam. The 10th FCS, originally the 4503rd TFS (Provisional), was in combat for almost 18 months.

F-5Cs were powered by two afterburning General Electric J85 turbojets. For low-speed operations, air louvre doors on the rear fuselage provided improved air flow.

Serving over Vietnam between October 1965 and April 1967, the USAF Skoshi Tigers flew 9985 missions, in which nine aircraft were lost. Around 17,000 general-purpose bombs had been dropped by the time these trials aircraft were handed over to South Vietnam.

The F-5's cockpit afforded good pilot visibility. Seated on a rocket-powered ejection seat, USAF Freedom Fighter pilots over Vietnam were fortunate that their aircraft had an additional 90 kg (200 lb) of cockpit and engine armour, upgraded avionics and an improved jungle camouflage scheme.

Mounted in the nose are two 20-mm (0.79-in) M39A2 lightweight cannon, with 280 rounds of ammunition. A nose-mounted refuelling probe and night formation lights were also added to USAF Freedom Fighters. South Vietnamese RF-5As carried four KS-92 cameras in a modified nose.

Skoshi Tiger aircraft typically carried mission markings. Flying up to four times a day, the 10th FCS was kept busy on light attack duties.

Underwing, on jettisonable pylons specifically fitted for Vietnam service, the F-5C carried up to 2720 kg (6,000 lb) of rockets, gun pods, bombs or, as shown here, four 340-kg (750-lb) BLU-1 anti-personnel napalm tanks.

F-5A Freedom Fighter

Type: lightweight fighter and fighter-bomber

Powerplant: two 18.15-kN (4,082-lb-thrust) General Electric J85-GE-13 afterburning turbojets

Maximum speed: 1487 km/h (924 mph) 'clean' at 10,975 m (36,000 ft)

Maximum climb rate: 8748 m/min (28,700 fpm) at sea level

Combat radius: 989 km (615 miles) on hi-lo-hi mission with two 240-kg (530-lb) bombs and maximum fuel

Service ceiling: 15,390 m (50,492 ft)

Weights: empty equipped 3667 kg (8,084 lb); maximum take-off 9379 kg (20,677 lb)

Armament: two 20-mm (0.79-in) M39 cannon and up to 1996 kg (4,400 lb) of air-to-ground ordnance

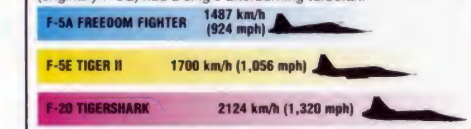
Dimensions:

span (with tip tanks)	7.87 m (25 ft 10 in)
length	14.38 m (47 ft 2 in)
height	4.01 m (13 ft 2 in)
wing area	15.79 m² (170 sq ft)

COMBAT DATA

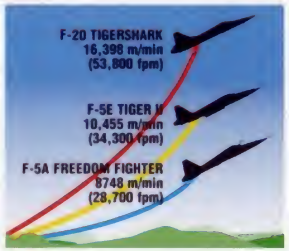
MAXIMUM SPEED

Northrop's F-5 family has been extensively developed from the Freedom Fighter to the Tiger II and ill-fated Tigershark. The F-5E Tiger II introduced more powerful J85 engines, and the F-20 (originally F-5G) had a single afterburning turbofan.



MAXIMUM CLIMB RATE

Increased engine power and improved power-to-weight ratios contributed greatly to climb rates. A good climb rate allows a fighter aircraft to reach its patrol station quickly. The F-20 lost out to the F-16A ADF in the race to equip the US Air National Guard with a new air-defence fighter.



ARMAMENT

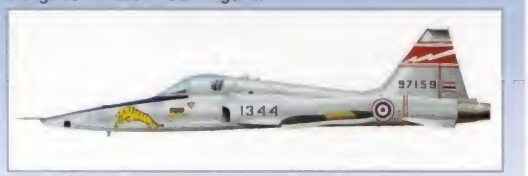
Greater engine power also allowed higher loads to be carried. When the F-20 appeared, its maximum weapons load was double that of the original F-5As.

Freedom Fighter operators

■ **ROYAL CANADIAN AIR FORCE:** Canada recently retired its last CF-5s, which had been upgraded for use as CF-18 lead-in trainers with reworked wings and tail plus new avionics.

■ **ELLINIKI AEROPORIA:** Greece flies two Freedom Fighter squadrons, including ex-Dutch aircraft, from Thessaloniki, mainly for light ground-attack and advanced weapons training duties.

■ **ROYAL THAI AIR FORCE:** Thailand operates the original F-5A/B and RF-5A in small numbers in the ground attack role, alongside the later F-5E/F Tiger II.



PANAVIA

TORNADO ADV

● Long-range bomber interceptor ● Swing-wing ● Iraq and Bosnia

▲ *The Tornado is the mainstay of Britain's long-range strike and air defence capability, and its pilots and navigators are among the best trained in the world.*

Resulting from the marriage of the Tornado strike aircraft with the Sky Flash missile, the Tornado ADV (Air Defence Variant) is a long-range interceptor designed to defend British airspace by engaging bombers hundreds of kilometres out over the ocean. It has advanced radar and fire-control avionics, and with its great reach and ability to shoot down missile-carrying attackers beyond visual range it is superbly capable at its assigned task.

PHOTO FILE

PANAVIA TORNADO ADV

Sidewinder-armed ▶
The Tornado's superb intercept capability has now been enhanced by the replacement of its long-serving Sky Flash and Sidewinder missiles with advanced AMRAAM and ASRAAM missiles.

▲ Combat patrol
The ADV was designed to mount combat air patrols and to intercept bombers far from the British coast. It has a very long endurance, and a powerful and highly sophisticated radar.

▲ Low and fast
The Tornado was originally designed as a low-level strike fighter, and as such it is one of the fastest aircraft in the world. But the engines were built to deliver low-level thrust, and at altitude they do not perform as well as could be expected.

▲ Tornado family
The ADV was derived from this strike variant, but has a longer fuselage with additional fuel and a longer nose to accommodate the Foxhunter radar.

Export fighter ▲
Saudi Arabia is the only other ADV operator, using the type in conjunction with F-15 Eagles.

◀ Desert defender
Tornados defended Saudi airspace during the 1991 Gulf War, and made strikes deep into Iraqi airspace during the 2003 invasion of the country.

FACTS AND FIGURES

- In 1976, it was revealed that 165 of the 385 Tornados ordered by the Royal Air Force would be interceptors.
- First flight of the definitive Tornado F.Mk 3 interceptor was on 20 November 1985.
- The final ADV was delivered to the RAF's No. 56 Squadron on 24 March 1993.
- The Tornado F.Mk 3 introduced an extended afterburner which increases fuselage length by 36 cm (14 in).
- The ADV's intercept radar is the GEC-Marconi AI.Mk 24 Foxhunter.
- Six Saudi ADVs and 38 British F.Mk 3s are equipped with full dual controls.

PROFILE

Defender of the Realm

The Tornado Air Defence Variant, designated Tornado F.Mk 3 in RAF service, is one of the world's most capable long-range interceptors. The pilot and radar officer of the Tornado ADV are strapped into a slender, graceful fuselage with ample room and visibility, which has been stretched from the original Tornado ground-attack variant.

The Tornado is quite heavy relative to its size, but enjoys enough thrust to climb to combat altitude even while accelerating. An afterburner take-off in this powerful machine, which can be accomplished in as little as 765 m (2,510 ft), is an unforgettable experience.

Although fairly agile, the Tornado is no dogfighter, and would be no match for a superfighter such as the Sukhoi Su-27 in a 'turn and burn' struggle. But apart from its limitations in close-quarter combat, the Tornado ADV is a fine warplane well equipped to deal with any bomber pilot with hostile intentions.

This clean, powerful interceptor has been purchased by Saudi Arabia, which has a similar geographic need to engage invading warplanes from long distance. Plans for a purchase by Oman were cancelled, but Italy operated 24 aircraft on loan from the RAF from 1995–2003.

Britain's air defence team for the 1990s consists of the ADV and the Boeing E-3D AWACS. The E-3D would allocate targets for ADV crews.

The IWKA-Mauser 27-mm (1.06-in) cannon, mounted beneath the cockpit on the starboard side of the fuselage, can fire a 25-round burst of high-explosive rounds in under a second.

Saudi ADVs are painted in an all-grey paint scheme. The Saudi IDS strike aircraft carry a brown striped colour scheme to blend in with the desert.

The ADV has the advanced Hermes RHAW (Radar Homing and Warning Receiver) to warn the crew of enemy radar emissions.

TORNADO ADV

The Royal Saudi Air Force has three Tornado ADV squadrons, operating in the air defence role alongside McDonnell Douglas F-15Cs.

As an interceptor, the ADV does not need the all-round visibility of a high-agility dogfighter from its comfortable, modern cockpit.

Saudi ADVs are full-capability aircraft, equipped to the same standard as the RAF's F.Mk 3. RSAF Tornados also carry 2250-litre (594-US gal) drop-tanks.

The ADV has only a single 27-mm (1.06-in) cannon, as the port cannon bay has been replaced by an air-to-air refuelling probe.

Development of the Foxhunter radar was plagued by problems, but effective troubleshooting means that it now has a very respectable performance. It has full lookdown/shootdown capability.

The Sky Flash semi-active radar missiles are mounted in recesses under the fuselage.

Four AIM-9 Sidewinder missiles are carried on the sides of the underwing stores pylons.

The RB.199 turbofans are equipped with thrust reversers for short-field landings.

Tornado F.Mk 3

Type: two-seat long-range interceptor

Powerplant: two Turbo-Union RB.199-34R Mk 104 turbofans each rated at 40.48 kN (9,104 lb thrust) dry and 73.48 kN (16,527 lb thrust) with afterburning

Maximum speed: 2338 km/h (1,453 mph) at 11,000 m (36,089 ft)

Intercept radius: 1800 km (1,118 miles) (subsonic) or 600 km (373 miles) (supersonic)

Service ceiling: 21,000 m (68,900 ft)

Weights: empty 14,500 kg (31,967 lb); loaded 27,986 kg (61,700 lb)

Armament: one 27-mm (1.06-in) IWKA-Mauser cannon; four BAe Sky Flash radar missiles; four AIM-9L Sidewinder heat-seeking missiles (in future, ADV may carry six AIM-120 AMRAAMs)

Dimensions:

span (swept)	8.60 m	(28 ft 3 in)
(spread)	13.90 m	(45 ft 7 in)
length	18.06 m	(59 ft 3 in)
height	5.70 m	(18 ft 8 in)
wing area	26.60 m²	(286 sq ft)

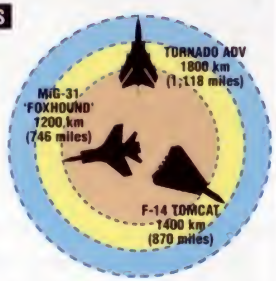
COMBAT DATA

MAXIMUM SPEED

The Tornado's clean design means that despite its engine problems, which manifest most obviously as slow acceleration, the aircraft is very fast at high level. It can outrun the larger F-14 Tomcat, although it is not in the same class as the massively powerful MiG-31.

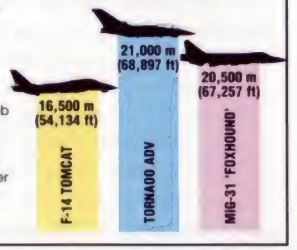
INTERCEPT RADIUS

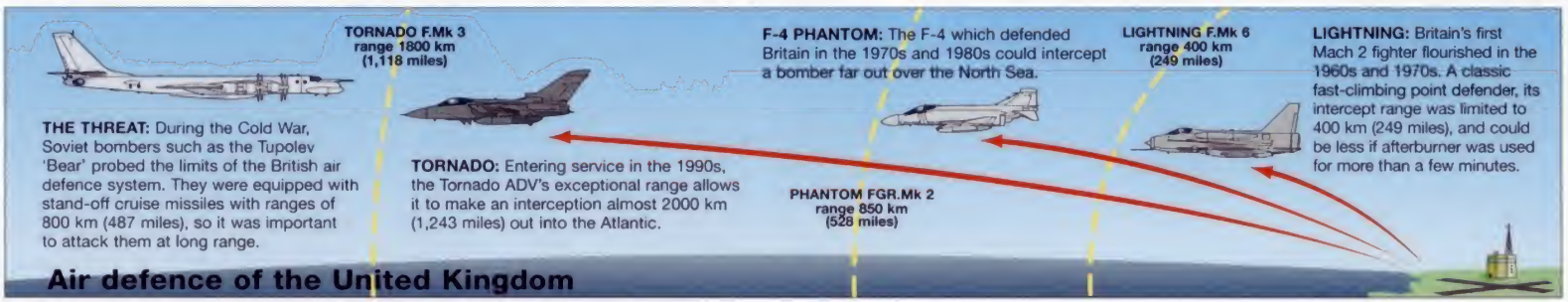
At optimum altitude, the Tornado's RB.199 turbofans are very fuel-efficient. Despite the fact that the relatively small Tornado carries so much less fuel than either the swing-wing Tomcat or enormous 'Foxhound', the Anglo/German/Italian jet has a much greater operational reach.



SERVICE CEILING

The Tornado was designed for low-level flight. However, its efficient moving wing design enables it to climb very high, although it uses fuel rather rapidly at extreme altitude. The MiG-31 uses brute power to achieve similar performance, while the Tomcat is less capable.





PANAVIA

TORNADO GR.MK 1

● Multi-role strike fighter ● Dangerous low-level missions

They flew the most dangerous air missions of the 1991 Gulf War. Hurtling through the desert night, less than 60 m (200 ft) above the ground, their targets were the heavily defended runways of Iraq's military airfields. And the perilous nature of their role is reflected in the fact that the RAF's Tornado GR.Mk 1s suffered proportionally the highest losses of all the aircraft taking part in Operation Desert Storm.

▲ *Tornados are designed to fly very fast and very low. Just how low is evident in this view from the cockpit of a Tornado as it races a hundred feet up through a desert 'wadi'.*

PHOTO FILE

PANAVIA TORNADO GR.MK 1

▲ Low-level attack
Germany's MW-1 weapon dispenses a mixture of anti-armour and anti-personnel submunitions for attacks on ground targets. The similar British JP233 is a specialized airfield attack weapon that is designed to crater runway surfaces.

▲ On the deck
The most modern equipment helps the pilot at low altitude. Control is largely automatic, the aircraft's terrain-following radar ensuring that a constant ground clearance is maintained.

Multi-mission ▶
The nose of Tornado 'MiG-Eater' records three JP233 missions, 23 bombing missions and 14 laser-guided bombing missions.

▼ Low-flying danger
Some crewmen, such as Jon Peters (inset), survived being shot down, getting out of their shattered Tornados only to suffer mistreatment at the hands of their captors.

▲ First mission
Strain shows on the faces of a returning Tornado crew after the first night's mission, along with relief at having survived unscathed.

FACTS AND FIGURES

- On the first three nights of the war Tornados flew 63 sorties, delivering JP233 runway attack munitions.
- Airfields hit included Al Asad, H-2, H-3, Shaibah, Tallil, Al Taqaddum and Ubaidah.
- Four Tornados were lost in the first five days, although only one carried JP233.
- Six RAF Tornados were lost in action, five crew being killed and seven captured.
- British Tornados flew a total of 1600 bombing missions during the war, or 1.4 per cent of the Coalition total.
- They delivered 100 JP233s, 4250 free-fall bombs and 950 laser-guided bombs.

PROFILE

1st Gulf War spearhead

In the words of Tornado pilot Flt. Lt. Ian Long: 'It was a very, very black night; probably one of the darkest I have ever flown on. Over the desert, especially over Iraq, there are no lights. You are flying very low, and all you see is the odd Bedouin camp flashing by.'

From the beginning of the First Gulf War, RAF and Saudi Tornados made their trademark high-speed attacks. Passing low over their target, the huge JP233 containers beneath the fuselage dispensed runway-cratering munitions and area-denial mines, designed to prevent repairs.

JP233 missions were among the most dangerous of the war. Five aircraft were lost to the full force of enemy anti-aircraft artillery.

'It's absolutely terrifying. You're frightened of failure; you're frightened of dying. You're flying as low as you dare but not too low to drop your weapons. You put it over the target as low as possible, and then you get away as fast as you can.'

The problem was the size and multiple runways of the Iraqi air bases. It didn't take the Tornado pilots long to work out that destroying the taxiways leading to the runways was the most effective way of making the airfield unusable.

The lack of air opposition later in the war testified that the incredible courage of the crews was not wasted, and the Tornado force had done its job.

JP233 is no lightweight. At 6 m (20 ft) long and weighing 2335 kg (5,148 lb), it needs a powerful machine such as the Tornado to carry its twin dispensers.

All of the Tornado's wing stations were occupied by tanks or defence pods, with weapons carried under the fuselage. The only exception were two Sidewinders carried for self-defence.

The Tornado's small swing wing minimizes low-level, high-speed turbulence, giving its two-man crew a very comfortable ride.

Tornado GR.Mk 1

Type: two-seat multi-role combat aircraft

Powerplant: two 38.49-kN (8,657-lb-thrust) Turbo-Union RB.199 Mk 103 turbofans (71.59 kN / 16,102 lb thrust with afterburning)

Maximum speed: 1482 km/h (921 mph) at low level

Combat radius: 1400 km (870 miles) on a typical hi-lo-hi attack mission

Service ceiling: more than 15,250 m (50,030 ft)

Weights: empty 13,890 kg (30,622 lb); loaded 27,950 kg (61,619 lb)

Armament: two 27-mm (1.06-in) IWKA-Mauser cannon each with 180 rounds, 9000 kg (19,842 lb) of ordnance ranging from WE177B nuclear bomb, JP233 or MW-1 airfield attack weapons, ALARM or HARM anti-radar missiles, Paveway laser guided bombs, and 550-kg (1,216-lb) free-fall or retarded HE bombs

Dimensions:

span (swept)	8.60 m	(28 ft 3 in)
(spread)	13.91 m	(45 ft 8 in)
length	16.72 m	(54 ft 10 in)
height	5.95 m	(19 ft 6 in)
wing area	26.60 m²	(286 sq ft)

TORNADO GR.MK 1 'MIG-EATER'

RAF Tornados in the Gulf were notable for their colourful nose art. 'MiG-Eater', depicted here, was based at Tabuk. It was one of the most heavily used Tornados, being flown on 40 missions.

Tornado carries the Sky Shadow electronic countermeasures pod. This detects and jams enemy fire-control radars across a wide range of frequencies.

The Tornado's multi-mode radar is its primary navigation and attack system. Behind the radar is the chisel-like housing for the laser seeker, used when dropping precision-guided munitions.

After the Iraqi airfields were neutralized, Tornados switched to laser-guided attacks, using British 500-kg (1,100-lb) bombs fitted with the Paveway II laser-guidance system. Two or three bombs were carried side by side on fuselage hardpoints.

The tip of the Tornado's large vertical tail houses a VHF communications aerial. A pair of Marconi radar-warning receivers, which detect enemy search radars, project fore and aft immediately beneath.

COMBAT DATA

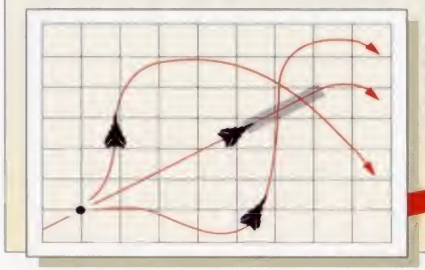
ATTACK HEIGHTS

Iraq's air bases were the Tornado's primary target, and were attacked with a number of different weapons. The two most effective required very different attack techniques.

JP233: Attacking with the specialized airfield denial weapon entailed approaching from as low as 75 m (246 ft), which made the fighter vulnerable to small arms and hand-held missiles.

LASER-GUIDED BOMBS: These were dropped with deadly accuracy from as high as 6100 m (20,000 ft), as seen here, in almost complete safety from enemy defences.

Tornado mission



1 INITIAL POINT: About 10 km (6 miles) from the target the Tornado reaches the IP, or initial point. This is the start of the bomb run itself, which is completely automatic.

2 WEAPONS RELEASE: The computerized fire-control system continually monitors aircraft speed, height and position, calculating the exact moment at which to release weapons in order to hit the target.

3 LAYDOWN ATTACK: Usually involving multiples of four aircraft attacking several hundred metres apart at intervals of a few seconds, often from different directions, this makes target acquisition much more difficult for the enemy's air defences.

4 ESCAPE: Once the weapons have been released the Tornado runs out at full speed in a more or less straight line, in order to minimize the time spent in detection and weapons firing range of the target's defences.

The armament is designed to penetrate and crater the runway.

REPUBLIC

F-84 THUNDERJET

● Ground attack ● Straight wings ● Korean War veteran

When the first F-84 Thunderjets reached Korea in December 1950, the USAF found itself with a fighter not quite ideal for air-to-air action but unmatched as a bomber and ground-attack platform. In a sense, the F-84 Thunderjet always played second fiddle; it was developed as 'insurance' early in the jet age and it remained in widespread service across Europe long after newer, faster jets stole the headlines.

▲ *Heading to the Korean war zone aboard a US Navy aircraft-carrier, Thunderjets and their pilots wait out the long cruise before their aircraft can be unloaded at the docks in Japan.*

PHOTO FILE

REPUBLIC F-84 THUNDERJET

▼ No runway required
Because runways are so vulnerable, some F-84s were fitted with a solid-fuel booster rocket, enabling them to be launched from the back of a lorry.

▲ The jet age
The XP-84 was rolled out in December 1945. Its clean lines were possible because the airframe was designed around an axial-flow engine.

▼ Rocket attack
This aircraft fires off a full load of ground-attack rockets on a practice range. The technique was used widely during the Korean War.

Star performers ▶
The 'Thunderbirds', the US Air Force's aerobatic team, flew F-84Gs from its inception in 1953 until the type was phased out in favour of swept-wing F-84Fs in 1955. Pilots praised the excellent handling of Republic's Thunderjet.

Tunnel vision ▶
The proposed XF-103 interceptor was fitted with a periscope, and the pilot flew the aircraft by looking through a sight.

FACTS AND FIGURES

- The F-84 was the first new American fighter to fly after the end of World War II in 1945.
- The first flight was made on 28 February 1946 at Edwards AFB in California.
- A record speed of 983 km/h (609 mph) was achieved on 6 September 1946.
- Thunderjets entered USAF service during the summer of 1947, and were initially known as P-84Bs; 'P' stood for pursuit.
- The F-84's first combat mission in the Korean War was on 6 December 1950.
- F-84s destroyed 105 MiG-15, mainly during ground-attack operations.

PROFILE

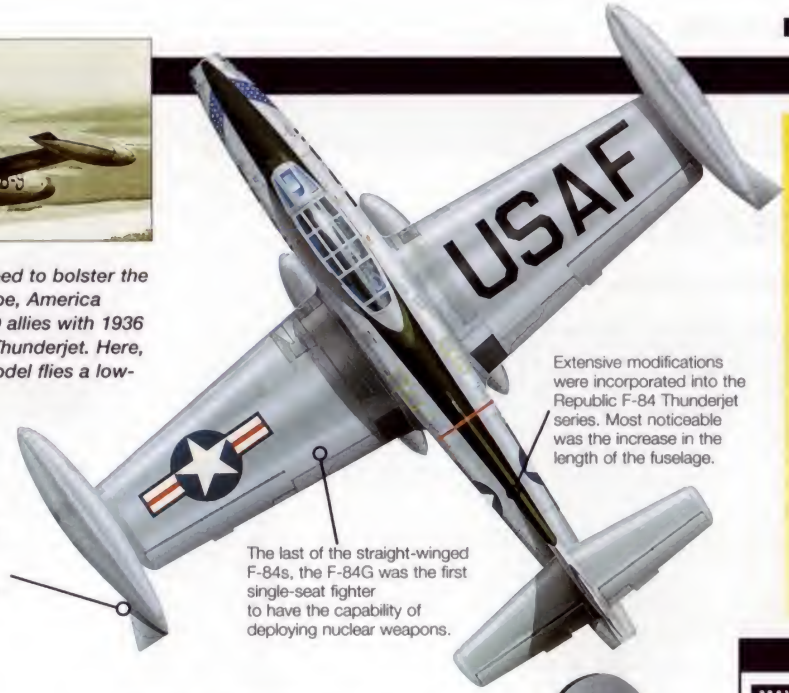
Straight-winged warrior

The straight-winged Republic F-84 Thunderjet was a solid and versatile jet fighter that poured from the factory production line at a time when aviation was being revolutionised by other jets with swept-back wings. The F-84 was nevertheless a tough and reliable combat aircraft that blazed a trail of glory in Korea and equipped NATO nations for many years.

Straight-winged F-84D, F-84E and F-84G fighters flew thousands of fighter-bomber missions in Korea and shot down a few MiG-15s. Others served as escort fighters with Strategic Air Command. The 'ultimate' straight-winged Thunderjet, the F-84G, was more powerful than earlier models and was equipped for in-flight refuelling from the beginning. These fighters were the first to deploy in large numbers across oceans, and established several records for mass ferry flights across the Atlantic and Pacific.

The basic design of the F-84 was so good that it led to a swept-winged version, which also served with distinction.

Faced with the need to bolster the defences of Europe, America supplied its NATO allies with 1936 examples of the Thunderjet. Here, an early Dutch model flies a low-level patrol.



Later models of the F-84 Thunderjet were equipped with tip tanks that allowed the aircraft to operate at greater range with no loss in speed.

The last of the straight-winged F-84s, the F-84G was the first single-seat fighter to have the capability of deploying nuclear weapons.

Extensive modifications were incorporated into the Republic F-84 Thunderjet series. Most noticeable was the increase in the length of the fuselage.

F-84E Thunderjet

Type: single-seat jet fighter-bomber

Powerplant: one 22.2-kN (5000-lb-thrust) Allison J35-A-17 turbojet

Maximum speed: 987 km/h (612 mph)

Initial climb rate: 1847 m/min (6060 fpm)

Range: 3138 km (1945 miles)

Service ceiling: 13,173 m (43,200 ft)

Weights: empty 4629 kg (10,183 lb); maximum take-off 10,189 kg (22,416 lb)

Armament: six 12.7-mm (.50-cal.) machine guns; plus up to 2041 kg (5000 lb) of bombs, or 32 HVAR rockets

Dimensions:

span	11.09 m (36 ft 4 in)
length	11.76 m (38 ft 7 in)
height	3.91 m (12 ft 9 in)
wing area	24.15 m² (260 sq ft)

F-84G THUNDERJET

Simple in design and layout, the Thunderjet offered the USAF an aircraft that could perform numerous operations during wartime. It earned the title of 'Champ of the Fighter-Bombers'.

The cockpit was enclosed under a sliding canopy. Later models were fitted with bracing struts to increase the strength of the hood against bird strikes. This also considerably eased construction of the canopy.

Having experienced developmental problems with the swept-winged F-84F, on the G model Republic re-introduced the straight wing to the USAF fighter fleet. Originally intended as purely an interim design, the F-84G was produced in the largest numbers and served with a number of NATO operators.

Six M-3 machine guns were positioned above the intake in the nose. Loading of the guns was accomplished via an upward-hinging door.

The F-84 was the first fighter to be fitted with an in-flight refuelling receptacle, which was positioned within the starboard tip tank. Tanker aircraft were the KB-29Ps of SAC.

Being equipped with an Allison J35 engine increased the F-84G's top speed to 1000 km/h (620 mph). This allowed the aircraft to be used for fighter and attack missions.

COMBAT DATA

MAXIMUM SPEED

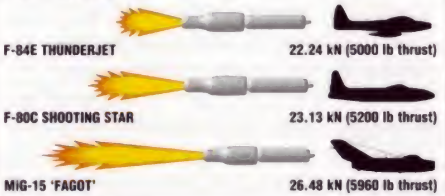
Though powered by an improved engine, the Thunderjet's maximum speed was limited by the type's straight-winged design. The Russians held the lead in fighter design with their MiG-15 'Fagot', aircraft which came as an unpleasant surprise to the USAF in Korea.

CLIMB RATE

With its ability to out-climb the Thunderjet, the MiG-15 was able to out-fight the F-84 whenever a dogfight occurred. Because of this, the F-84 was restricted to ground attack duties for which an escort of fighters could be provided.

THRUST

Early jet engines were often limited in their power output, and the F-84E Thunderjet offered low performance compared to its contemporaries. The earlier F-80C Shooting Star had increased thrust but was unable to perform the many attack duties of the F-84E Thunderjet.



Thunder over Europe

■ **DENMARK:** Denmark received its aircraft as part of the NATO build-up after World War II. The Thunderjet was the first Danish fighter to enter service after the war.

■ **PORTUGAL:** Operating well into the 1970s, the Thunderjet flew with numerous NATO allies including Belgium, Italy and Portugal. It was eventually replaced by the Mirage and F-104.

■ **TURKEY:** This brightly coloured example flew with the Turkish air force display team. Examples were operated in the ground-attack role and on fighter duties.

REPUBLIC

F-84F THUNDERSTREAK

● NATO ground attacker ● Tactical nuclear bomber ● Reconnaissance

▲ *The Republic F-84 was a mainstay of NATO fighter strength in the 1950s and 1960s. Tasked with the vital tactical nuclear delivery role in the 1960s, it was the post-war Luftwaffe's first jet.*

Republic's F-84F Thunderstreak hit the scene when the straight-wing F-84 was rebuilt with swept wings, reconfigured air intake and canopy, and an improved engine. The resulting fighter-bomber served the United States and 12 other nations, mostly in NATO, for over a decade. This subsonic warplane was heavy and was never more than an adequate performer, but its versatility ensured a long career.

PHOTO FILE

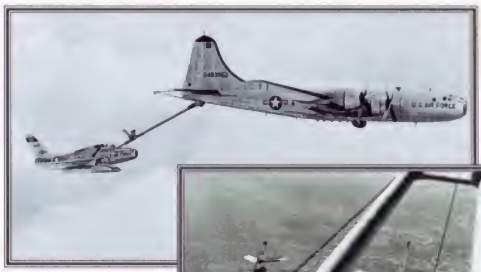
REPUBLIC F-84F THUNDERSTREAK

▲ Photo jet
The RF-84F was a photo reconnaissance variant, with side-mounted intakes to allow for the large camera-filled nose section.

Rocket strike ▶
The Thunderstreak could launch all 24 of its 7-cm (2.76-in) rockets in one salvo. These weapons were very powerful, if not too accurate.

▲ Deadly arsenal
The Thunderstreak could deliver a shattering array of weaponry, including rockets, 20-mm cannon fire, napalm and nuclear bombs.

▼ Hooked up
Aerial refuelling was vital to the nuclear-strike role. Despite this, pilots knew that most missions would be 'one way'.



▲ Fire-bomb practice
The F-84F never dropped napalm in anger, unlike the straight-winged F-84G, which did so in Korea. This aircraft is unloading over a Nevada range in 1954.

Tanker's eye view ▶
This refuelling method requires the fighter merely to fly straight and level, as the boom operator does all the difficult work from the tanker.

FACTS AND FIGURES

- The YF-96, essentially the prototype for the F-84F, first flew on 3 June 1950.
- The first F-84F flew in 1951, but engine snags delayed service delivery until 1955.
- In all 2713 F-84Fs were built: 2476 by Republic and 237 by General Motors' Kansas City Division.
- At the height of the Cold War in 1965, 57 per cent of the fighter-bombers in Western Europe were Thunderstreaks.
- The YF-84J test ship, based on an F-84F, had a much more powerful engine.
- The Italian air force aerobatic team flew F-84Fs between 1957 and 1959.

PROFILE

NATO's tactical nuclear striker

The rocket-armed F-84F was an extremely potent tactical fighter in the 1950s and 1960s. Few would have guessed that the aircraft would still be providing useful service to NATO in the early 1980s, flying tactical reconnaissance missions for the Greek and Turkish air forces.

Developmental problems were rampant when Curtiss-Wright built a licensed British Sapphire engine for a swept-wing F-84, which was at first designated YF-96. The engine never yielded the 34.7 kN (7,804 lb thrust) once promised, but the F-84F proved successful, partly because it was tough and strong, and could deliver a potent load of bombs.

Early hopes that the Thunderstreak might prove to be a MiG-killer were forlorn: the F-84F introduced a new standard of precision as a fighter-bomber, but other performance shortfalls made it an adequate dogfighter at best.

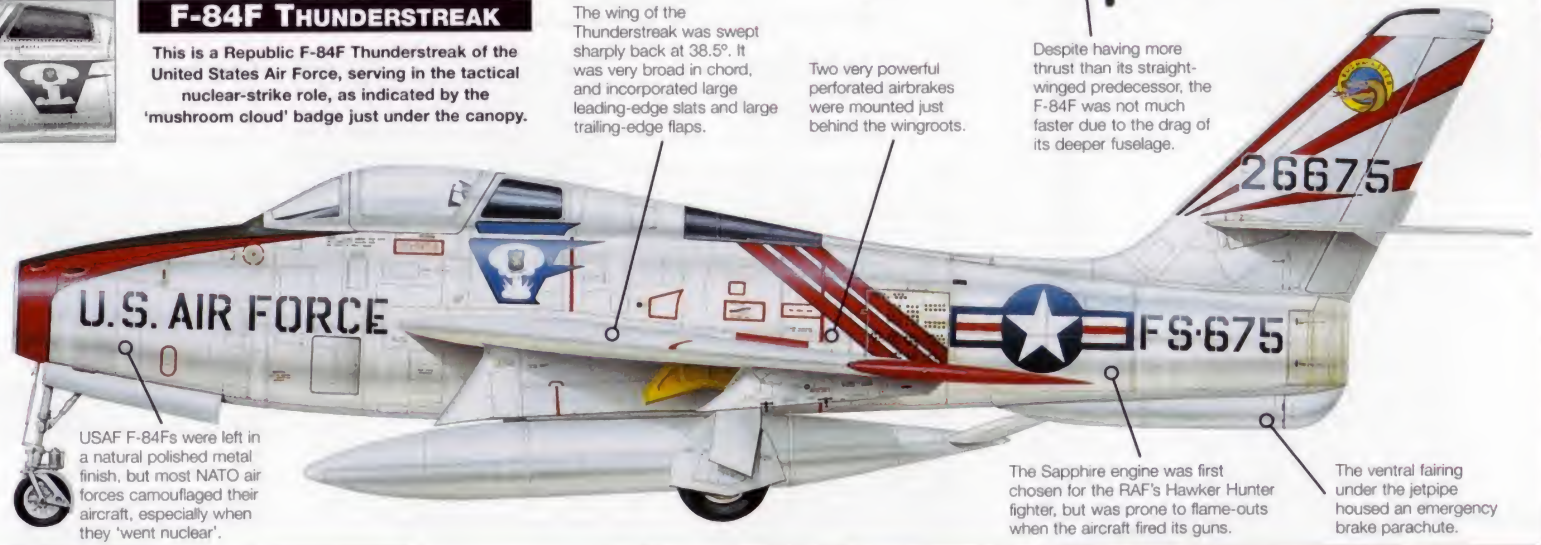
Although it was a little heavy on the controls, the F-84F gave its pilot a roomy cockpit with fair visibility. In some units pilots relentlessly practised a 'lob' technique to deliver tactical atomic bombs. In nuclear war, their mission would have taken them one-way to Russia or Eastern Europe. Most F-84F outfits in the United States and NATO had a conventional mission, however, as did the Air National Guard squadrons which used this fighter-bomber late in its career.

F-84F THUNDERSTREAK

This is a Republic F-84F Thunderstreak of the United States Air Force, serving in the tactical nuclear-strike role, as indicated by the 'mushroom cloud' badge just under the canopy.

The F-84F wing had a pronounced 'anhedral', angled downward from the wingroot, giving lively handling characteristics.

F-84Fs were usually fitted with two very large tanks when flying in the nuclear-strike role. The nuclear bomb went on the aircraft's centre pylon.



The wing of the Thunderstreak was swept sharply back at 38.5°. It was very broad in chord, and incorporated large leading-edge slats and large trailing-edge flaps.

Two very powerful perforated airbrakes were mounted just behind the wingroots.

Despite having more thrust than its straight-winged predecessor, the F-84F was not much faster due to the drag of its deeper fuselage.

USAF F-84Fs were left in a natural polished metal finish, but most NATO air forces camouflaged their aircraft, especially when they 'went nuclear'.

The Sapphire engine was first chosen for the RAF's Hawker Hunter fighter, but was prone to flame-outs when the aircraft fired its guns.

The ventral fairing under the jetpipe housed an emergency brake parachute.

F-84F Thunderstreak

Type: single-seat fighter-bomber

Powerplant: one 32.12-kN (7,224-lb-thrust) Wright/Buick J65-W-3 Sapphire turbojet engine

Maximum speed: 1118 km/h (695 mph) at sea level

Combat radius: high altitude with two drop-tanks 1304 km (810 miles)

Service ceiling: 14,020 m (46,000 ft)

Weights: empty 6273 kg (13,830 lb); loaded 12,700 kg (28,000 lb)

Armament: six 12.7-mm (0.5-in) Browning M3 machine guns, up to 2722 kg (6,000 lb) of external bombs and rockets including tactical nuclear weapons

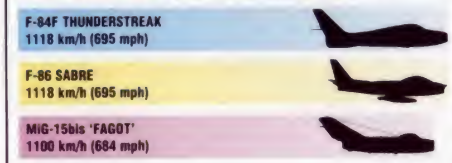
Dimensions:

span	10.24 m (33 ft 7 in)
length	13.23 m (43 ft 5 in)
height	4.38 m (14 ft 4 in)
wing area	30.19 m² (325 sq ft)

COMBAT DATA

MAXIMUM SPEED

Although on paper the Thunderstreak was as fast as both the MiG-15 and the Sabre, it was never able to match the other two swept-wing jets in combat, as its pilots encountered severe and sometimes fatal handling problems in high-*g* manoeuvring.

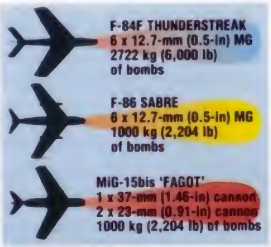


FERRY RANGE

The swept-wing F-84's deep fuselage could hold a great deal of fuel, and with underwing tanks it had probably the longest range of any tactical fighter of the early 1950s. This, together with its speed, made it suitable for the deep penetration nuclear strike mission to which it was assigned.

ARMAMENT

As with most Republic fighter designs, the Thunderstreak was a big, heavy and tough machine, able to carry and deliver a heavy weapons load with considerable precision. In common with most American fighters of the period, however, its gun fit was less powerful than was standard in European warplanes.



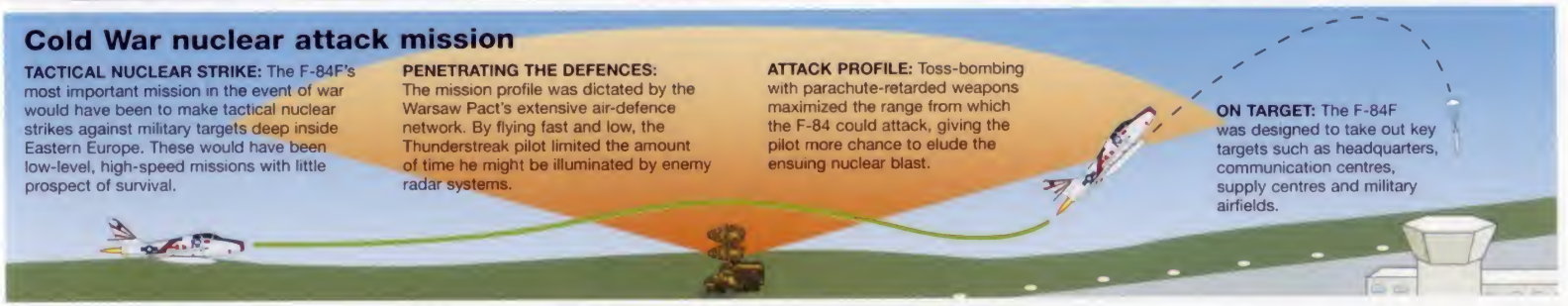
Cold War nuclear attack mission

TACTICAL NUCLEAR STRIKE: The F-84F's most important mission in the event of war would have been to make tactical nuclear strikes against military targets deep inside Eastern Europe. These would have been low-level, high-speed missions with little prospect of survival.

PENETRATING THE DEFENCES: The mission profile was dictated by the Warsaw Pact's extensive air-defence network. By flying fast and low, the Thunderstreak pilot limited the amount of time he might be illuminated by enemy radar systems.

ATTACK PROFILE: Toss-bombing with parachute-retarded weapons maximized the range from which the F-84 could attack, giving the pilot more chance to elude the ensuing nuclear blast.

ON TARGET: The F-84F was designed to take out key targets such as headquarters, communication centres, supply centres and military airfields.



REPUBLIC

F-105 THUNDERCHIEF

● Fighter-bomber ● Heavy ordnance load ● MiG-killer

▲ *During the arduous Rolling Thunder bombing campaign which lasted from 1965 to 1968, the US Air Force's F-105D Thunderchiefs bore the brunt of the missions. The aircraft were mainly employed in large strike packages, attacking strategic targets.*

On a bombing mission to Hanoi, Republic F-105 Thunderchief pilots faced considerable danger. Surface-to-air missiles (SAMs), anti-aircraft guns and MiG fighters were all intent on downing the Thunderchief before it reached its target. Geography, however, gave the F-105 pilot one ally; a high ridge known as 'Thud Ridge' which extended from the Laotian border almost to Hanoi, along which targets could be approached in relative safety.

PHOTO FILE

REPUBLIC F-105 THUNDERCHIEF

◀ **Early 'Thuds'**
Some of the first F-105Ds to reach Vietnam retained their buzz-number below the cockpit. During 1965 a programme of camouflage application began.

▲ **Into combat**
All F-105D units were based in Thailand and undertook long transit flights to reach targets in North Vietnam.

▲ **Takhli Thunder**
'RU'-tailcodes indicate that this aircraft was based at Takhli Royal Thai Air Force Base.

◀ **Air-to-air**
Seen through the sight of a second F-105D, a Thunderchief is engaged by a MiG-17.

◀ **Rolling Thunder**
Seen at the height of Rolling Thunder operations during 1967, these fully camouflaged F-105s typify the many hundreds engaged in combat.

▲ **Essential refuelling**
Such was the length of F-105 missions that air-to-air refuelling was a feature of most sorties.

FACTS AND FIGURES

- During much of the Vietnam War, F-105 'fighters' bombed strategic targets while B-52 'bombers' flew tactical missions.
- Two F-105 pilots were awarded the Medal of Honor for their courage.
- F-105 pilots were required to complete 100 missions before leaving Vietnam.
- According to one analysis, an F-105 pilot would almost certainly be shot down by the time of his 68th sortie.
- F-105Ds shot down 25 MiGs, using cannon and AIM-9 Sidewinder missiles.
- The value of all aircraft lost in Vietnam was estimated at US$3,129,948,000.

PROFILE

Fighting 'Thuds' over Vietnam

Almost one-third of all Republic F-105 Thunderchiefs came to the end of their lives in the fiercely defended skies over North Vietnam, with a total of 397 being lost during the conflict. It was hostile terrain, except for the jagged, 100-km (62-mile) ridge line which aircrews called 'Thud Ridge' after the nickname of their F-105s.

An F-105, or 'Thud' heading north from Thailand with a typical load of eight 340-kg (750-lb) bombs would be able to attack its target successfully only by outwitting the enemy's missiles, MiGs, and anti-aircraft fire. Typically, the F-105 pilot refuelled from a tanker, communicated with a command and control aircraft or a forward air controller (FAC), and then plunged into the hell of enemy airspace. Many aircraft fell and a host of pilots died fighting the most comprehensive anti-aircraft defences assembled up to that time.

Often, the pilot's approach to the target included hiding behind 'Thud Ridge' for a portion of the trip. This enabled the F-105 to attack targets like Kep airfield near Hanoi with a degree of surprise. It was some of the most dangerous flying in the history of air warfare, but the F-105 was a fine aircraft and its well-trained pilots fought valiantly, attacking ground targets and destroying MiG-17s in air-to-air combat.

Decades after the conflict, the F-105 is still highly regarded by all who flew it.

Below: Preparing for a 1962 weapons meet at Nellis Air Force Base, Nevada, this F-105 demonstrates the combat readiness of USAF aircrews and their aircraft.

Above: This 355th Tactical Fighter Wing (TFW) aircraft carries a load of M117 and Mk 82 bombs, some with extended fuses.

F-105D Thunderchief

Type: single-seat tactical fighter

Powerplant: one 117.92-kN 26,532-lb-thrust) Pratt & Whitney J75-P-19W afterburning turbojet engine

Maximum speed: 2237 km/h (1390 mph) at 10,975 m (36,000 ft)

Initial climb rate: 10,515 m/min (34,498 fpm)

Combat range: 2975 km (1849 miles)

Service ceiling: 15,850 m (52,000 ft)

Weights: empty 12,474 kg (27,500 ft); maximum take-off 23,834 kg (52,545 ft)

Armament: one 20-mm M61A1 Vulcan cannon with 1028 rounds plus, typically, eight 340-kg (750-lb) bombs on a bombing mission to Hanoi or a maximum of 6350 kg (14,000 lb) of ordnance

Dimensions:

span	10.65 m (34 ft 11 in)
length	19.58 m (64 ft 3 in)
height	5.99 m (19 ft 8 in)
wing area	35.76 m² (385 sq ft)

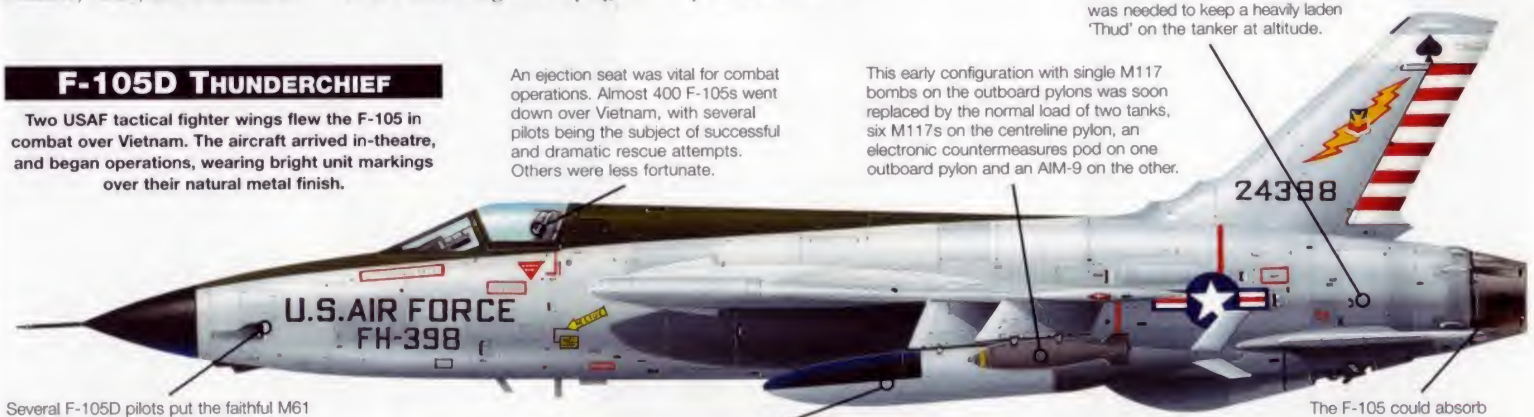
F-105D Thunderchief

Two USAF tactical fighter wings flew the F-105 in combat over Vietnam. The aircraft arrived in-theatre, and began operations, wearing bright unit markings over their natural metal finish.

Even though it offered 117.92 kN (26,532 lb thrust), the J75 engine left the F-105D underpowered. Afterburner was needed to keep a heavily laden 'Thud' on the tanker at altitude.

An ejection seat was vital for combat operations. Almost 400 F-105s went down over Vietnam, with several pilots being the subject of successful and dramatic rescue attempts. Others were less fortunate.

This early configuration with single M117 bombs on the outboard pylons was soon replaced by the normal load of two tanks, six M117s on the centreline pylon, an electronic countermeasures pod on one outboard pylon and an AIM-9 on the other.



Several F-105D pilots put the faithful M61 20-mm, six-barrelled cannon to good use. The majority of F-105 MiG-17 kills were achieved with the cannon, although at least three involved AIM-9 Sidewinder shots.

A 1703-litre (375-gallon) drop tank was carried on each inboard wing pylon for most missions. In-flight refuelling was also necessary, but once topped up the F-105D could remain on station for long periods, with its large ordnance load giving good combat persistence.

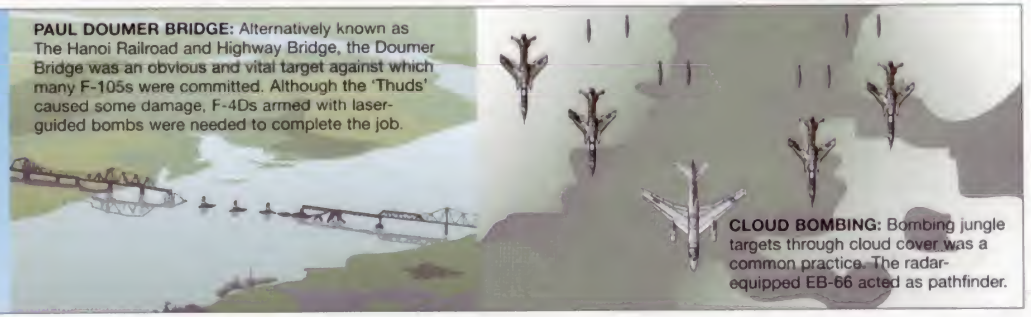
The F-105 could absorb extensive combat damage. One aircraft returned with an accidentally fired AIM-9 embedded in the tailpipe!

'Thud' combat versatility

WEAPONS AND TACTICS: Having entered the war mainly as a 'dumb' bomber, the F-105 acquired new weapons and tactics.

BULLPUP OPERATIONS: F-105Ds employed the AGM-12A/B Bullpup missile against the Thanh Hoa Bridge, with little success.

PAUL DOUMER BRIDGE: Alternatively known as The Hanoi Railroad and Highway Bridge, the Doumer Bridge was an obvious and vital target against which many F-105s were committed. Although the 'Thuds' caused some damage, F-4Ds armed with laser-guided bombs were needed to complete the job.



CLOUD BOMBING: Bombing jungle targets through cloud cover was a common practice. The radar-equipped EB-66 acted as pathfinder.

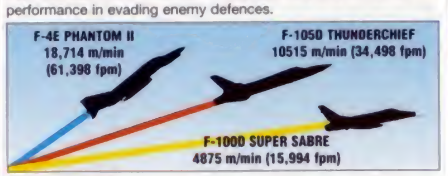
COMBAT DATA

MAXIMUM SPEED

Until the McDonnell Douglas F-4 began to reach the Vietnamese theatre in numbers, the F-105D was one of the USAF's fastest combat aircraft. These figures are for speed 'clean' at altitude, but the F-105D was easily supersonic, bombed-up, at sea level.

CLIMB RATE

Even by today's standards the F-4E offered outstanding climb performance. The powerful Thunderchief was a better performer than the older North American F-100D and was able to use its performance in evading enemy defences.



ARMAMENT

All three of these tactical aircraft featured gun armament. That on the F-4E was rushed into service in this model of Phantom after all-missile-armed F-4s had highlighted the need for guns during close-in air-to-air combat.

ROCKWELL

B-1A

● Mach 2 bomber prototype ● Four built ● Predecessor of B-1B Lancer

Rockwell's B-1A was the great white hope of the late 1970s while the Cold War was raging. This was a 'swing-wing' bomber, capable of supersonic speed and hauling heavy bombs, that would finally, belatedly, replace the B-52 Stratofortress. However, those who complained that the B-52 should have been retired long before were premature if they expected the B-1A to replace it. President Jimmy Carter had other ideas.

▲ *Rolled out on 26 October 1974 and first flown on 23 December, the first of four B-1A prototypes was 74-0158. The expense of the programme was the major factor in its cancellation.*

PHOTO FILE

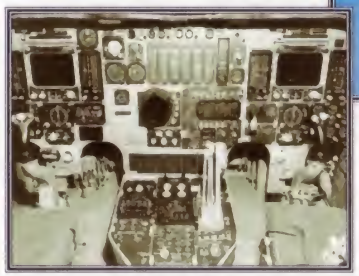
ROCKWELL B-1A

▼ Mach 2 top speed
The Rockwell B-1A was designed from the outset to be capable of twice the speed of sound at altitude.

▲ Crew escape capsule
Like the F-111 before it, the B-1 employed a crew escape capsule rather than ejection seats to allow the crew to leave the aircraft in an emergency at high speed. Normal ejection at high speeds would be fatal.

Swing wings ▶
A key feature of the B-1 was its swing wings, fully forward (15° sweep) for low-speed flight and landing, and swept to 67° for high-speed dashes.

▼ Cockpit layout
The B-1 featured fighter-type control sticks, vertical scale flight instruments and TV screens for a forward-looking infra-red image.



Prototype tests ▶
The prototype first flew from Palmdale, California. Subsequent testing was carried out at Edwards AFB.

FACTS AND FIGURES

- The prototype B-1A first flew on 23 December 1974 and made 79 test flights totalling 405 flight hours.
- The second B-1A crashed on its 127th flight on 29 August 1984, killing the pilot.
- B-1As had a crew of four: two pilots and offensive and defensive systems officers.
- On 19 April 1976 the US Secretary of Defense, Donald Rumsfeld, flew a B-1A with a Rockwell test pilot.
- The second and fourth B-1As were used as test aircraft for B-1B development.
- On 5 October 1978, the second B-1A briefly hit a speed of Mach 2.22.

PROFILE

SAC's ill-fated Mach 2 bomber

The Rockwell B-1A was the bomber of the 1970s that paved the way for the Rockwell B-1B Lancer, 100 of which were built in the 1980s.

However, the B-1A differed from the Lancer in several important ways. It was designed to fly at Mach 2, bomb from high altitude and have only a limited low-level capability. It had greater wing sweep and bomb-carrying capacity and had a very different avionics fit.

From 1974 until 1977, three glossy-white B-1As flying at Edwards Air Force Base, California, were believed to be prototypes of a new Strategic Air Command bomber, one that would supplant the ageing Boeing B-52 Stratofortress which was scheduled to retire in 1975.

A contract for the Advanced Manned Strategic Aircraft (AMSA) was awarded in 1970, with the first B-1A flying in 1974.

In 1977, President Carter struck what appeared to be a fatal blow by cancelling the B-1A programme. Concerns were raised regarding the huge cost of the 240 aircraft that SAC had requested. It was concluded that the job of striking at the Soviet Union could be carried out by B-52s armed with 'stand-off' weapons. Besides, any new manned bomber would have to be optimized for low-level flight. When Ronald Reagan became president in 1981, he revived the B-1 to create just such an aircraft, the B-1B.

Below: The B-1A's undercarriage retracted into the fuselage between the engine nacelles. Each main leg was supported by a four-wheel bogie.

Above: Unusually, the first flight of the prototype B-1A was also the first flight of the YF101 turbofan. New engines are more often tested in an existing airframe before being flown in a new aircraft type.

B-1A

Type: strategic bomber

Powerplant: four 136.93-kN (30,797-lb-thrust) General Electric F101-GE-100 turbofan engines with afterburning

Maximum speed: Mach 2.22 or 2351 km/h (1,461 mph) at 15,240 m (50,000 ft)

Range: 9815 km (6,099 miles)

Service ceiling: 12,000 m (39,370 ft)

Weights: empty approx. 72,575 kg (160,000 lb); maximum take-off 176,810 kg (389,800 lb)

Armament: maximum of 52,160 kg (114,993 lb) of stores, including up to 24 1016-kg (2,240-lb) AGM-69A Short-Range Attack Missiles (SRAMs), Air-Launched Cruise Missiles (ALCMs) and decoy missiles

Dimensions:

span (swept)	23.84 m (78 ft 3 in)
span (unswept)	41.67 m (136 ft 9 in)
length	45.78 m (150 ft 2 in)
height	10.24 m (33 ft 7 in)
wing area	181.2 m² (1,950 sq ft)

B-1A

Glossy-white 74-0158 was the first of three B-1A protótypes built and test flown before cancellation in 1977. A fourth example flew in 1979 after the Carter Administration agreed to allow testing to continue.

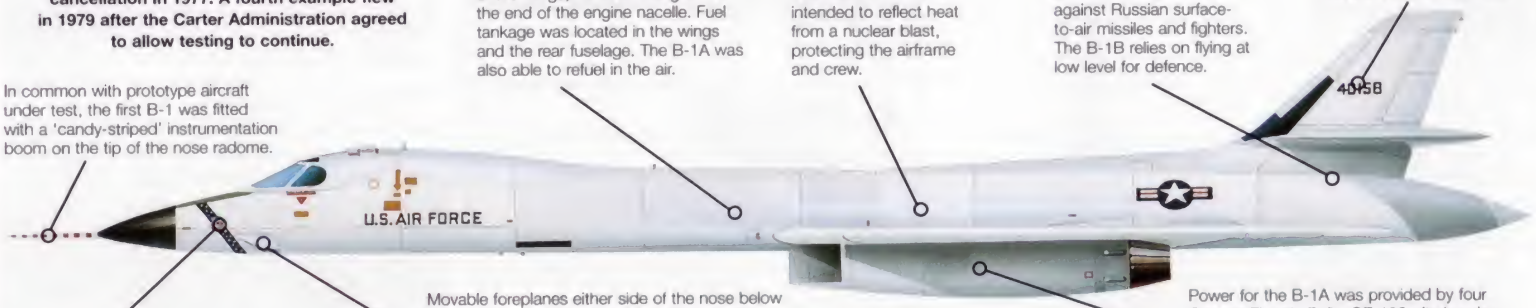
In common with prototype aircraft under test, the first B-1 was fitted with a 'candy-striped' instrumentation boom on the tip of the nose radome.

Two of the three 4.57-m (12-ft) long weapons bays were located ahead of the wings, the third being above the end of the engine nacelle. Fuel tankage was located in the wings and the rear fuselage. The B-1A was also able to refuel in the air.

The high-altitude bombing role of the B-1A was reflected in the 'anti-flash' white colour scheme applied to the prototypes. Anti-flash schemes are intended to reflect heat from a nuclear blast, protecting the airframe and crew.

An 'all-moving' tailplane was fitted. Below this, in the rear fuselage, was a large avionics bay. The B-1A was equipped with a comprehensive electronic countermeasures suite to provide some protection against Russian surface-to-air missiles and fighters. The B-1B relies on flying at low level for defence.

The first three prototypes carried the serials 74-0158, -0159 and -0160. The fourth aircraft, 76-0174, did not fly until 1979, after the B-1A programme was cancelled.



A blue ribbon decorated with stars and highlighting the Strategic Air Command emblem was wrapped around the nose.

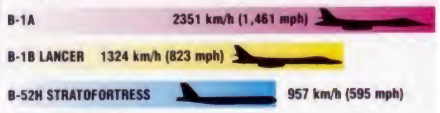
Movable foreplanes either side of the nose below the cockpit were part of the Low-Altitude Ride Control (LARC) system. This was designed to make the often bumpy conditions during high-speed flight at low altitude more bearable.

Power for the B-1A was provided by four General Electric F101-GE-100 afterburning turbofans. This engine was test flown in such aircraft as the F-16 fighter and was the basis for the later F110 turbofan.

COMBAT DATA

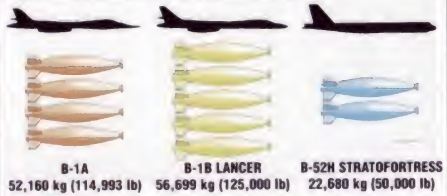
MAXIMUM SPEED

The B-1A's Mach 2 capability was sacrificed in the B-1B in order to improve other performance features. Wing sweep was reduced and engine air intakes were simplified. Both types outperformed the ageing B-52, however.



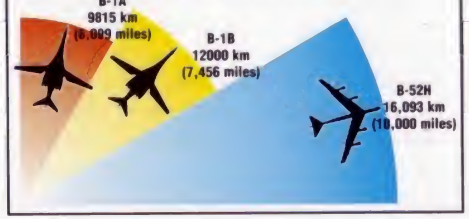
ARMAMENT

The B-1B was required to carry an even larger load than that of the B-1A and a wider variety of weapons. The B-52 can only carry about half this load, but over a greater range.



RANGE

The B-52's exceptional range is hard to better in an aircraft such as the B-1. The B-52 was intended to carry a relatively light nuclear bombload over very long ranges. While the B-1A was short on range, the B-1B was an improvement.



USAF jet bomber prototypes

■ **CONVAIR XB-46:** Straight-winged, four-engined and the USAF's fastest bomber when it first flew, the B-46 did not reach production.

■ **CONVAIR YB-60:** Based on the B-36, the B-60 was Convair's 1950s bomber contender in the competition won by the Boeing B-52.

■ **NORTH AMERICAN XB-70 VALKYRIE:** Intended to replace the B-52, the Mach 3 XB-70 was cancelled in the late 1960s. Two were built.

■ **NORTHROP YRB-49A:** One of the Northrop 'flying wing' family, the six-engined RB-49 would have been used as a reconnaissance bomber.

SAAB

J 35 DRAKEN

● Double-delta design ● Attack fighter ● Tactical reconnaissance

Sweden took a revolutionary leap forward with the Saab J 35 Draken. Offering an innovative double-delta wing, surprisingly low cost and multi-role prowess, the Draken (Dragon) symbolizes Saab's boldness and independence. The Draken was futuristic when it entered service in 1960, and is still formidable approaching retirement today. This excellent aircraft flew in 17 versions, winning acclaim in military roles ranging from Mach 2 interceptor to combat trainer.

▲ *The Draken was the keystone of Sweden's air defence system, combining conscript ground crews with first-class modern equipment.*

PHOTO FILE

SAAB J 35 DRAKEN

▲ Scandinavian defender
In spite of the Draken's quality, export success was limited. It was sold to all Scandinavian air forces except Norway, with Denmark the only NATO user.

▲ Falconers
The Draken was one of the few jets to be armed with the Hughes Falcon series of missiles, built in Sweden as Rb 26 and Rb 28, in both radar and infra-red versions.

▲ Uprated Draken
The improved J 35D featured an uprated engine based on the Avon 300, a 'zero-zero' ejection seat, extended air intakes and a badly needed increase in internal fuel capacity.

▼ Afterburner take-off
The Draken engine is based on the Rolls-Royce Avon, as used in the Lightning. Take-offs using afterburner have the same dramatic character.

▲ Dragon's lair
Drakens are based at normal airfields, but in emergencies the Swedish air force would disperse them to well-camouflaged roadside hides.

FACTS AND FIGURES

- First prototype of the Saab J 35 Draken made its initial flight on 25 October 1955.
- The Draken was vectored to its targets by Sweden's STRIL-60 datalink system.
- The J 35D, first flown on 27 December 1960, had an improved engine and better avionics than earlier versions.
- During 1964, four Drakens formed the Swedish 'Acro Delta' aerobatic team.
- Austria was the last export customer for the Draken, acquiring 24 modified J 35Ds.
- F10 Wing at Angelholm is the last Swedish air force Draken unit, operating the two remaining squadrons.

PROFILE

Sweden's double-delta dragon

Saab's amazing Draken is still unique, four decades after its first flight. Paving new aerodynamic ground with the double-delta wing, tested in 1952 on the subscale Saab 210, the Draken was ready to fly in 1956. By March 1960 the Draken, with its British-designed engine, Swedish electronics and American Falcon missiles, was 'standing alert' with the Swedish air force's F13 Wing at Norrkoping.

Many new Drakens came along over the years. The J 35B was primarily an interceptor, first flown on 29 November 1959. The J 35D had a more powerful engine. The S 35E was a dedicated reconnaissance version, and the Sk 35C was a two-seat trainer.

The 'ultimate' Draken was the J 35F, which equipped eight wings of the Swedish air force. It had improved radar, a single cannon and an infra-red sensor to pick out a target nearly 30 km (19 miles) away. Upgraded as the J 35J, it remained operational in small numbers into the 1990s.

Armed with Sidewinder and Falcon missiles and its hard-hitting 30-mm (1.18-in) cannon, the Draken remains a potent fighter. New pilots still ask to fly this old jet.

Early Drakens carried a pair of British-developed ADEN 30-mm (1.18-in) cannon in the leading edges of the wings, but later variants such as the J 35F have only one gun.

Drakens are powered by Swedish-built variants of the Rolls-Royce Avon, delivering some 8 tonnes (9 tons) of thrust.

The distinctive 'double-delta' wing plan has reduced supersonic drag compared to pure deltas, and also performs better at low airspeeds.

Each of the Draken's control surfaces was operated by two separate hydraulic jacks.

The Draken has had various colour schemes in Swedish service. Those remaining in service are all-over air defence grey. The Draken started life in a natural polished metal finish, some receiving this 'splinter' camouflage in the 1960s and 1970s.

J 35F DRAKEN

The J 35F was the most capable Draken, 230 of which were produced for Sweden. Though approaching its last days, some upgraded versions still remain in service with the F10 wing.

The cockpit is narrow, cramped, and uses very old control technology. Yet it remains popular with pilots, possibly because it is a challenge to fly.

The limited rear view from the cockpit was a feature the Draken shared with most of its contemporaries.

The Draken had one of the most advanced fire-control systems of its day, combining the Ericsson PS-01a radar with an infra-red sensor. The sensor could detect targets as far away as 27 km (18 miles).

There are eight stores stations: two fuselage and six underwing.

A small auxiliary tailwheel under the jetpipe was needed to prevent 'tail scrapes' when the Draken landed.

J 35J Draken

Type: single-seat interceptor

Powerplant: one 78.46-kN (17,647-lb-thrust) Volvo Flygmotor RM6C turbojet (Rolls-Royce RB.146 Avon 300 fitted with Volvo-designed afterburner)

Maximum speed: Mach 2 or 2125 km/h (1,320 mph) at 11,000 m (36,089 ft)

Combat radius: 720 km (447 miles)

Service ceiling: 20,000 m (65,617 ft)

Weights: empty 8250 kg (18,188 lb); loaded 12,270 kg (27,051 lb)

Armament: one 30-mm (1.18-in) ADEN M/55 cannon with 90 rounds, two Rb 27 radar missiles and four Rb 28 Falcon or Rb 24 Sidewinder infra-red missiles, or 2900 kg (6,393 lb) of ordnance

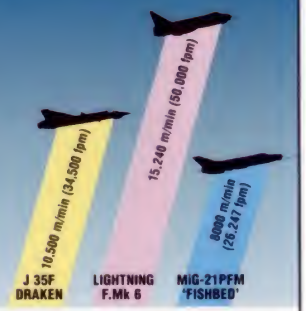
Dimensions:

span	9.40 m (30 ft 10 in)
length	15.35 m (50 ft 4 in)
height	3.89 m (12 ft 9 in)
wing area	49.20 m² (530 sq ft)

COMBAT DATA

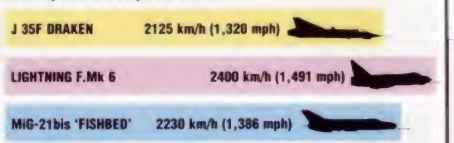
CLIMB RATE

The Draken had an excellent initial climb rate, making it well suited to the role of quick-reacting bomber-interceptor. It could easily outperform contemporary MiG designs, but was unable to catch the Lightning, which with two Rolls-Royce Avon engines had twice the power of the Swedish jet.



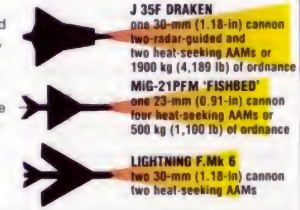
MAXIMUM SPEED

Most fighters of the late 1950s could comfortably break Mach 2. The Draken was almost as fast as the smaller and lighter MiG-21, but fell behind the much bigger and far more powerful Lightning flown by Britain's Royal Air Force.



ARMAMENT

The Draken was one of the first jets designed as a weapons system, with detection, fire control and weaponry all in one integrated unit. It was vastly more sophisticated than its MiG contemporary, and carried a bigger and better-balanced weapons fit than the Lightning.



Mach 2 trailblazers

■ **ENGLISH ELECTRIC LIGHTNING:** Britain's first Mach 2 fighter was as dramatic in its own way as the Draken. Based on the P.1 experimental plane of the early 1950s, the Lightning used immense power to achieve supersonic performance.

■ **LOCKHEED F-104 STARFIGHTER:** Known as 'the missile with a man in it', the Starfighter, like the Draken, was powered by a single powerful engine. It flew for the first time in February 1954, a year before the Draken prototype.

■ **DASSAULT MIRAGE III:** Also a delta-winged design, the Mirage III flew in 1956, a year after the Draken. Unfettered by the strict Swedish neutrality which limited Saab's sales of its equally effective design, the French exported Mirages widely.

SAAB

AJ/SF/SH VIGGEN

● All-weather reconnaissance ● Ground attack ● Double-delta

▲ *Although it is a complex machine, the systems used in the Viggen allow Sweden's conscript airmen to maintain it with ease after only 11 months of national service.*

Designed in the early 1960s to replace the J 32 Lansen, the Saab Viggen was one of the first modern fighters to fly with delta wings and canard foreplanes. The canards gave the aircraft excellent manoeuvrability, and in combination with the delta-wing layout produced the short take-off performance the Viggen required to operate from the stretches of highway that the Swedish air force plans to use in the event of war.

PHOTO FILE

SAAB AJ/SF/SH VIGGEN

◀ Complex camouflage
Sweden has one of the most complex colour schemes used on modern tactical aircraft. It is referred to as 'Fields and Meadows'.

▼ Ship search
A dedicated sea reconnaissance variant is used for patrols over the Baltic Sea.

◀ Short landing run
Slots in the rear fuselage are connected to the nosewheel and open upon landing to direct the engine thrust forwards.

▼ Snag-free start
These early production Viggens are not camouflaged. The aircraft experienced few difficulties on entering operational service.

▲ Worthy replacement
The Viggen has replaced the Lansen in most roles, although a few Lansens remain with second-line units and perform electronic warfare duties during air combat exercises.

FACTS AND FIGURES

- The fuselage of the Viggen has a honeycomb construction to reduce the weight of the airframe.
- The Viggen's tail folds down to allow it to operate from underground shelters.
- Low-pressure tyres enable the Viggen to operate from roads when necessary.
- Reconnaissance versions can be armed with bombs and missiles, and are also able to perform attack missions.
- During the Cold War, reconnaissance Viggens monitored Soviet warships.
- Missions can be undertaken in all weathers and at any time of day or night.

PROFILE

Sweden's delta defender

Although the JA 37 interceptor variant had the most demanding performance requirements, the AJ 37 attack variant was the first Viggen to fly, in February 1967. The Viggen's structure and systems, including a digital computer and head-up display, were as advanced as the aerodynamics. Its primary weapons were anti-ship and air-to-surface missiles.

Alongside the attack and interceptor variants, Saab developed two other specialized combat versions of the Viggen. The SF 37 is a photographic reconnaissance aircraft which is equipped with optical and infra-red cameras in place of the nose radar. The SH 37 variant carries a modified radar plus various camera and electronic surveillance pods for the maritime reconnaissance role. Production totalled 109 AJ, 28 SF and 27 SH aircraft, plus 17 Sk 37 two-seat trainers.

In 1992 the Swedish air force started an upgrade programme for 115 of its AJ/SF/SH 37s. They have been equipped to carry new weapons and sensors, and the AJ 37s have been fitted with the SH 37's radar. The modified aircraft have been redesignated AJS 37s.

Displaying its 'chisel' nose, this Viggen is equipped with a Red Baron reconnaissance pod on its forward fuselage station.

Reconnaissance Viggens, such as the SF, usually have their nose radars replaced by a battery of cameras. The AJ and SH models, however, retain the standard conical radome.

A heavily strengthened, single-piece wraparound windscreen gives the pilot an excellent view forward.

The Viggen's canard foreplanes enable it to take-off and land in much shorter distances than fighters without them.

Simple oval inlets are positioned on either side of the cockpit. Although they are not fitted with variable centrebodies or wall angles, they offer full protection against ice.

The complex colour scheme allows the aircraft to be easily hidden from view when operating away from conventional airfields. Each colour is precisely positioned on the airframe.

SF 37 VIGGEN

This example of the specialized overland multi-sensor SF 37 reconnaissance version serves with F21 at Lulea. These aircraft do not carry any offensive weapons, but fly alongside the armed SH 37 variants.

The cockpit is extremely well equipped, with multi-function displays presenting all the necessary information. The large size of the cockpit is appreciated by pilots flying long overland patrols.

Viggens are fitted with the Red Baron multi-sensor pod, which allows operations to be flown at night. Images are produced by conventional cameras and an infra-red line scanner.

Slots in the fuselage open when the aircraft lands, directing the engine thrust forwards.

AJ 37 Viggen

Type: fighter-bomber

Powerplant: one 115.72-kN (26,027-lb-thrust) Volvo Flygmotor RM8A afterburning turbofan

Maximum speed: 2125 km/h (1,320 mph) at 11,000 m (36,090 ft)

Initial climb rate: 10,000 m (32,808 ft) in less than 100 sec

Range: 500–1000 km (311–621 miles) plus, depending on attack profile

Service ceiling: 18,300 m (60,040 ft)

Weights: empty 11,800 kg (26,015 lb); maximum take-off 20,500 kg (45,195 lb)

Armament: Penguin anti-ship or Maverick air-to-surface or Sidewinder air-to-air missiles plus gun or rocket pods, or up 5000 kg (11,023 lb) of bombs

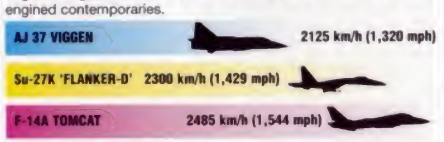
Dimensions:

span	10.60 m (34 ft 9 in)
length	16.30 m (53 ft 6 in)
height	5.80 m (19 ft)
wing area	46.00 m² (495 sq ft)

COMBAT DATA

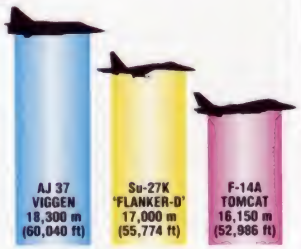
MAXIMUM SPEED

Although the Viggen's powerplant was developed from a civil engine design, the AJ 37's speed is comparable to that of its twin-engined contemporaries.



SERVICE CEILING

Sweden's position meant that the ability to intercept high-flying Soviet bombers was a major design requirement for the Viggen. The unique wing layout enables the aircraft to reach an extremely high operating altitude in the minimum amount of time to position for attack.



MAXIMUM TAKE-OFF WEIGHT

Despite all of the advantages that the Viggen offers, its operational weight is limited by its single engine. Both the American F-14 and Russian Su-27 are able to lift greater loads because of their increased thrust and extra stores pylons.

Viggen testers

■ **MiG-29A 'FULCRUM':** Soviet fighters continually probed Swedish airspace, which has often resulted in the Viggen being the first Western aircraft to observe new models.

■ **MiG-31 'FOXHOUND':** This big Soviet fighter has been a constant customer for the Viggen over the Baltic, with aircraft being deployed in the Kola Peninsula region.

■ **Su-27 'FLANKER-B':** The expansion of the Soviet fleet saw the development of an aircraft-carrier. If equipped with the latest fighters this would have presented a major problem for Sweden.

SEPECAT

JAGUAR GR.MK 1/GR.MK 1B

● Anglo-French single-seat attack aircraft ● Gulf War veteran

One of the early successes of Anglo-French collaboration, the Sepecat Jaguar fighter-bomber has been a mainstay of the RAF's first-line squadrons since the 1970s. With its improved weaponry and avionics the Jaguar has developed into a useful tactical ground-attack and reconnaissance aircraft, despite what is a modest performance when compared to some of its contemporaries.

▲ *It was thought that the Jaguar was in the twilight of its career when both French and RAF aircraft were sent to the Gulf to participate in Operation Desert Storm. Since then a new RAF version, the GR.Mk 1B, has entered service equipped with the TIALD imaging and laser pod.*

PHOTO FILE

SEPECAT JAGUAR GR.MK 1/GR.MK 1B

B-24 bombload ▶
This GR.Mk 1 carries eight 454-kg (1,000-lb) bombs, equivalent to the tonnage carried by a wartime B-24 Liberator bomber. A more normal load includes chaff and flare pods, fuel tanks and a pair of infra-red missiles.

◀ The 'front office'
This pilot's eye view of a single-seater's cockpit shows that it is fairly typical of a jet fighter-bomber of the 1970s.

Multi-role aircraft ▶
When originally delivered to the RAF, Jaguars were tasked with nuclear strike, reconnaissance and conventional attack. Only the latter role is still performed.

▲ Motorway take-off
Demonstrating its ability to operate from dispersed sites, this Jaguar lifts off from a stretch of motorway with a load of cluster bombs.

▼ T.Mk 2 two-seater
The two-seat conversion trainer version of the GR.Mk 1 features a longer nose with the crew seated in tandem under separate canopies.

FACTS AND FIGURES

- During the Cold War there were up to five RAF 'Jag' squadrons in Germany, the theoretical 'front line' in a major conflict.
- A Jaguar was once accidentally shot down by an RAF Phantom in Germany.
- Jaguars in the Gulf were armed with iron bombs, cluster bombs and rockets.
- During Operation Desert Storm, 12 RAF Jaguars flew 618 war sorties during January and February 1991.
- The home base of the RAF's Jaguar squadrons is RAF Coningsby.
- An RAF Jaguar once survived a high-speed wire strike at an altitude of just 10 m (33 ft).

PROFILE

The RAF's feline mud-mover

Throwing a fast fighter-bomber through mountains at night, without radar, alone and unaided by a navigator, may seem a recipe for disaster, but this is what RAF Jaguar pilots do on a regular basis. They know that the Jaguar, with more than 30 years of service behind it, is a tried and tested weapon that will not let them down.

When it came to a real war situation in the Gulf in 1991, the Jaguar showed that it was able to fly missions as well as many considerably younger aircraft.

A Franco/British project, the result of collaboration between the British Aircraft Corporation (now British Aerospace) and Dassault-Breguet, the SEPECAT Jaguar was first flown on 8 September 1968 as a single-seat attack aircraft with limited all-weather capability. It was intended to serve both the Armée de l'Air and the RAF; the French Jaguar A entered service first, in May 1972.

The RAF was to take delivery of its first GR.Mk 1 in May 1973. A well-equipped tactical strike-fighter, its equipment included an inertial navigation system, a head-up display and laser rangefinder. From 1983 navigation upgrades resulted in the GR.Mk 1A. Some were able to perform a secondary reconnaissance role.

The GR.Mk 1B and two-seat T.Mk 2B were introduced in 1995, equipped with the TIALD (Thermal Imaging and Laser Designation) pod. This allows a Jaguar to deliver its own laser-guided weapons.

Jaguars are fitted with a retractable inflight-refuelling probe which greatly increases their range capability.

Jaguars were the first RAF attack aircraft sent to the Gulf after the Iraqi invasion of Kuwait.

RAF aircraft are equipped with 'zero-zero' ejection seats. These can be used at 'zero height' and 'zero forward speed'.

XZ364 is armed for a typical Gulf War mission with four 454-kg (1,000-lb) bombs, a jamming pod under the port wing, a chaff dispenser under the starboard and AIM-9 missiles for self-defence.

Jaguar GR.Mk 1A

Type: single-seat attack bomber

Powerplant: two 35.77-kN (8,045-lb-thrust) Rolls-Royce/Turboméca Adour Mk 104 afterburning turbofans

Maximum speed: Mach 1.5 or 1690 km/h (1,050 mph) at altitude

Combat radius: 852 km (529 miles) on internal fuel

Service ceiling: 14,020 m (45,997 ft)

Weights: empty 7000 kg (15,432 lb); maximum take-off 15,442 kg (34,044 lb)

Armament: two 30-mm (1.18-in) ADEN cannon plus provision for two AIM-9L Sidewinder air-to-air missiles on overwing pylons, plus up to 4534 kg (9,996 lb) of underwing stores on five pylons

Dimensions:

span	8.69 m (28 ft 6 in)
length	15.52 m (50 ft 11 in)
height	4.92 m (16 ft 2 in)
wing area	24.18 m² (260 sq ft)

JAGUAR GR.MK 1A

XZ364 'Sadman' was one of a detachment of Jaguars from the RAF Coltishall Jaguar Wing based at Muharraq, Bahrain, and one of two RAF 'Jags' that flew 47 missions each in the Gulf.

Like the RAF Tornado bombers and Buccaneers in the Gulf, Jaguars were painted in a temporary 'desert pink' camouflage.

The fin fairing contains a radar-warning receiver which warns the pilot when he is 'illuminated' by enemy radar.

The Jaguar is unusual in being able to carry a pair of air-to-air missiles on overwing pylons. RAF Jaguars use AIM-9 Sidewinders.

Nose art was a feature of RAF aircraft during the Gulf conflict. This one features a caricature of Iraqi leader Saddam Hussein. The bomb symbols below the cockpit each represent missions flown.

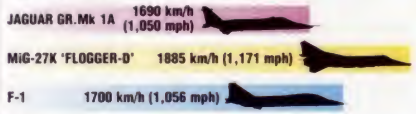
RAF single-seat Jaguars are fitted with the 'chisel-nose' containing a Ferranti Laser Rangefinder and Marked Target Seeker (LRMTS).

Continuing the Rolls-Royce tradition of naming its engines after rivers, the Jaguar's Anglo-French Rolls-Royce/Turboméca Adour turbofans are named after a river in France.

COMBAT DATA

MAXIMUM SPEED

For ground-attack aircraft, speed at ground level is far more important than absolute maximum speed. All three aircraft have similar performance at lower levels.



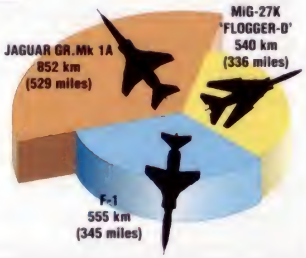
ARMAMENT

The Jaguar is an excellent attack aircraft with the ability to carry a useful bombload, including laser-guided bombs, deep into enemy territory. The F-1 carries far less than the MiG-27 or the Jaguar.

JAGUAR GR.Mk 1A	MiG-27K 'FLOGGER-D'	F-1
2 x 30-mm cannon	1 x 30-mm cannon	1 x 20-mm cannon
4534 kg (9,996 lb) of ordnance	4000 kg (8,818 lb) of ordnance	2721 kg (6,000 lb) of ordnance

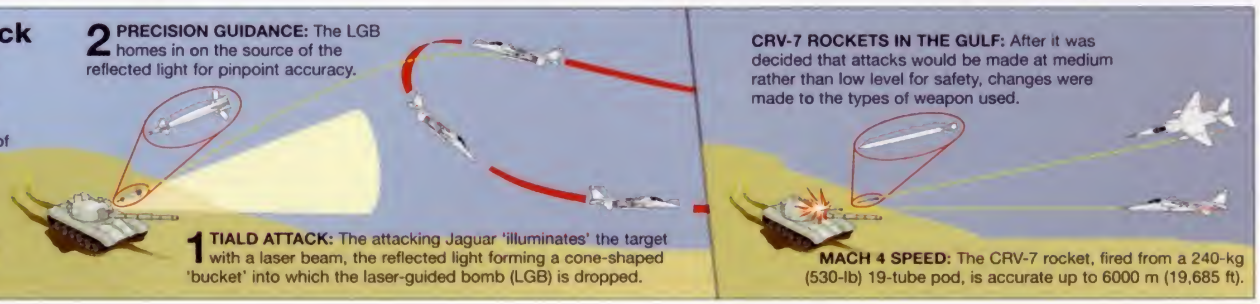
COMBAT RADIUS

With a typical bombload the Jaguar can strike deeper into enemy territory than the MiG-27 or the F-1. This capability was shown to good effect in the Gulf War when RAF and French Jaguars attacked targets deep inside Iraq.



Jaguar ground attack

IN THE GULF AND BEYOND: Typical ordnance loads during the Gulf War included general-purpose iron bombs, cluster bombs and rocket pods. Since then the RAF has equipped a number of single- and two-seat Jaguars with the TIALD pod which was used briefly by Tornados during Operation Desert Storm. This allows Jaguars to deliver highly accurate laser-guided munitions autonomously, as well as to 'illuminate' targets for other aircraft.



SIKORSKY

S-61/SH-3 SEA KING

● Anti-submarine helicopter ● In service for 30 years

As a true rotorcraft pioneer, Sikorsky was quick to realize the potential of the helicopter for anti-submarine warfare (ASW) operations. With its HSS-1 Sea Bat already in service, Sikorsky designed the HSS-2 Sea King as its turbine-engined replacement. The company could not have envisioned that the Sea King would become one of the world's most important helicopters, in service with the US Navy (USN) and many export customers.

▲ *One of the world's best known helicopters, the Sikorsky S-61 is also one of the longest-serving. Although now a rare sight in US Navy colours, the type continues to fly with other air arms.*

PHOTO FILE

SIKORSKY S-61/SH-3 SEA KING

▼ Topex

An SH-3H, belonging to HS-9 from Carrier Air Wing 8 aboard the USS Nimitz, flies in company with a Brazilian Navy machine during the annual 'Topex' anti-submarine warfare exercise in the Atlantic.

▲ Space rescue

Sea Kings were used for recovering astronauts after the Apollo lunar landings.

Dual-role helicopter ▶

In the early 1970s the USN needed a helicopter to perform both plane guard and ASW duties aboard its attack carriers and the SH-3 proved ideal.

▼ Enduring design

Despite being in service for more than 40 years, the S-61's outward appearance has surprisingly changed very little, though the latest versions are considerably more capable than early variants.

▼ Helicopters for the White House

Possibly the most glamorous of all S-61s are the VH-3Ds in use as VIP transports for the US president and government officials.

FACTS AND FIGURES

- Sea Kings were heavily involved in Vietnam, rescuing many downed USN pilots during the long conflict.
- A small number of RH-3A minesweeper variants entered service in 1964.
- The Royal Canadian Navy was the first export customer, ordering 41 of the type.
- Aeronautiche Giovanni Agusta acquired a licence to assemble Sea Kings for the Italian air force and navy.
- Argentina is unique in that it operates both Sikorsky- and Agusta-built examples.
- The SH-3 has been replaced by aboard USN carriers by the SH-60F Sea Hawk.

PROFILE

Backbone of the world's navies

Known by Sikorsky as the S-61 and by the US Navy as the SH-3, the Sea King still serves in considerable numbers, having flown for the first time on 11 March 1959.

Combining the roles of submarine hunter and killer thanks to its Bendix AQS-10 dipping sonar, Ryan APN-130 radar, and torpedo or depth bomb weapon load, the SH-3A was an instant success. The few remaining USN Sea Kings have all been upgraded to SH-3H standard. The design has also formed the basis of the much-modified Westland Sea King.

In addition to its ASW machines, the USN also flew nine examples of the specialized RH-3A minesweeping version of the basic SH-3, while a number of combat search and rescue HH-3 aircraft, also based on the SH-3 airframe, were built for the US Air Force.

Above: SH-3s can actually be refuelled in flight, although the usual method is somewhat different from that shown here!

Export customers included Argentina, Brazil, Canada, Denmark, Iran, Italy, Japan, Malaysia, Peru, Spain, and the UK. Several of these deals have included production licences.

Below: In Italian naval service, the Agusta SH-3Ds wear this dark sea grey colour scheme with high visibility Day-Glo noses and tail bands.

SPECIFICATION SH-3H Sea King

Type: anti-submarine and plane guard shipboard helicopter

Powerplant: two 1044-kW (1,400-hp) General Electric T58-GE-10 turboshafts

Maximum speed: 267 km/h (166 mph)

Cruising speed: 219 km/h (136 mph)

Initial climb rate: 670 m/min (2,198 fpm)

Range: 1005 km (624 miles)

Service ceiling: 4480 m (14,698 ft)

Weights: empty 4428 kg (9,762 lb); loaded 9525 kg (21,000 lb)

Accommodation: two pilots and two systems operators

Dimensions:

rotor diameter	18.90 m (62 ft)
length	22.15 m (72 ft 8 in)
height	5.13 m (16 ft 10 in)
rotor disc area	280.47 m² (3,019 sq ft)

SH-3H SEA KING

This SH-3H of HS-7 'Shamrocks' served aboard the USS *John F. Kennedy* (CV-67) during the carrier's 1983–84 Atlantic cruise.

Powering the SH-3H variant are two General Electric T58-GE-10 turboshafts. These provide impressive performance for a relatively large helicopter and generate up to 1044 kW (1,400 hp) each, allowing the aircraft to carry substantial underslung loads if so required.

All Sea Kings are fitted with five-blade main rotors. These can be folded aft and are interchangeable. They also feature the Sikorsky spar inspection system, which releases an inert gas if the blades are cracked, thus alerting maintenance staff to potential problems.

All Sikorsky S-61s are amphibious and are capable of landing on water for brief periods if necessary. The underside of the fuselage is sculpted to act as a watertight hull.

Equipment unique to the USN 'H' variant includes an AQS-13B sonar, a Canadian Marconi surveillance radar, and towed magnetic anomaly detector for hunting submarines.

The anti-torque tail rotor is fitted on the port side and also features five blades. A single stabilizer is fitted on the opposite side. The entire tail section is movable and can hinge to starboard for accessibility and stowage below carrier decks.

ACTION DATA

POWER

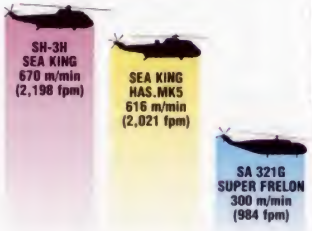
Even when it entered service, the Sikorsky Sea King was a powerful machine, able to lift substantial loads. In later years Westland built its own version with more powerful engines.

RANGE

When employed for plane guard or search-and-rescue duties the Sea King does not operate far afield. In the ASW role Sea Kings work with longer-ranged fixed-wing aircraft. The bigger Aérospatiale Super Frelon is primarily a tactical transport helicopter

CLIMB RATE

Despite being fitted with more powerful engines, the Westland Sea King performs less well than its slightly older Sikorsky cousin. The lumbering Super Frelon is very slow by comparison.



Sea King goes foreign

■ **BRAZILIAN NAVY SH-3D:** A number of machines were delivered to the Brazilian Navy and operated by 1° Esquadro de Helicopteros Anti-submarinos from Sao Pedro de Aldeida.

■ **JMSDF HSS-2B:** Mitsubishi of Japan acquired a licence to build Sea Kings and Japan's Maritime Self-Defence Force uses the type for anti-submarine warfare and rescue duties.

■ **SPANISH SH-3D:** This smart example is one of a batch of ex-USN machines transferred to Spain. These have been upgraded to SH-3H standard and serve with Escuadrilla 001.

SIKORSKY

S-65/CH-53

● Heavylift transport helicopter ● Combat rescue ● Minesweeper

One of the rotary-wing marvels of the Vietnam era, the Sikorsky S-65 was the largest helicopter built outside the USSR. Its dynamic parts (rotor, gearboxes and control system) were developed from those of the earlier S-64 SkyCrane and made extensive use of titanium. Fitted with folding rotor blades for shipboard stowage and given the designation CH-53 Sea Stallion by the US Marines, the S-65 emerged as the world's most capable assault transport.

▲ *Powerful and adaptable, the CH-53 revolutionised Western helicopter operations when introduced in the 1960s, and has proved extremely capable in a variety of land-based and seaborne roles.*

PHOTO FILE

SIKORSKY S-65/CH-53

◀ Grenada attack
The CH-53 saw action in the US invasion of Grenada, landing large numbers of Marines. The CH-53 fleet suffered no casualties in the operation, although UH-60s and AH-1s were shot down.

▲ Heavy lifter
The CH-53 was one of the few helicopters in Vietnam that could recover damaged aircraft, such as this Grumman A-6D.

▼ Soldiering on
Although succeeded in the 1980s by the more powerful CH-53E Super Stallion, the CH-53D remains in widespread service.

▲ Vietnam airlift
The CH-53 won its laurels in Southeast Asia, flying in difficult 'hot and high' conditions and constantly threatened by ground fire. It is seen here delivering Marines to the besieged base at Khe Sanh.

◀ Green Marine
In Marine Corps service, the CH-53 is based on 'Tarawa'-class assault ships. It is the largest troop lifting asset available to the USMC.

FACTS AND FIGURES

- US Air Force CH-53 cargo-haulers and HH-53B/C 'Super Jollies' began reaching Vietnam in 1967.
- The interior of the CH-53 is fitted with rollers for easy movement of cargo.
- Air Force special operations HH-53Hs and MH-53Js are rebuilds of HH-53B/Cs.
- Germany has the biggest fleet of S-65s outside the USA. VFW-Fokker licence-built 110 of the helicopters for the army.
- RH-53Ds were used as transports in the hostage rescue attempt in Iran in 1980.
- Marine pilots demonstrated that the S-65 could perform loops and rolls.

PROFILE

Sikorsky's strong lifter

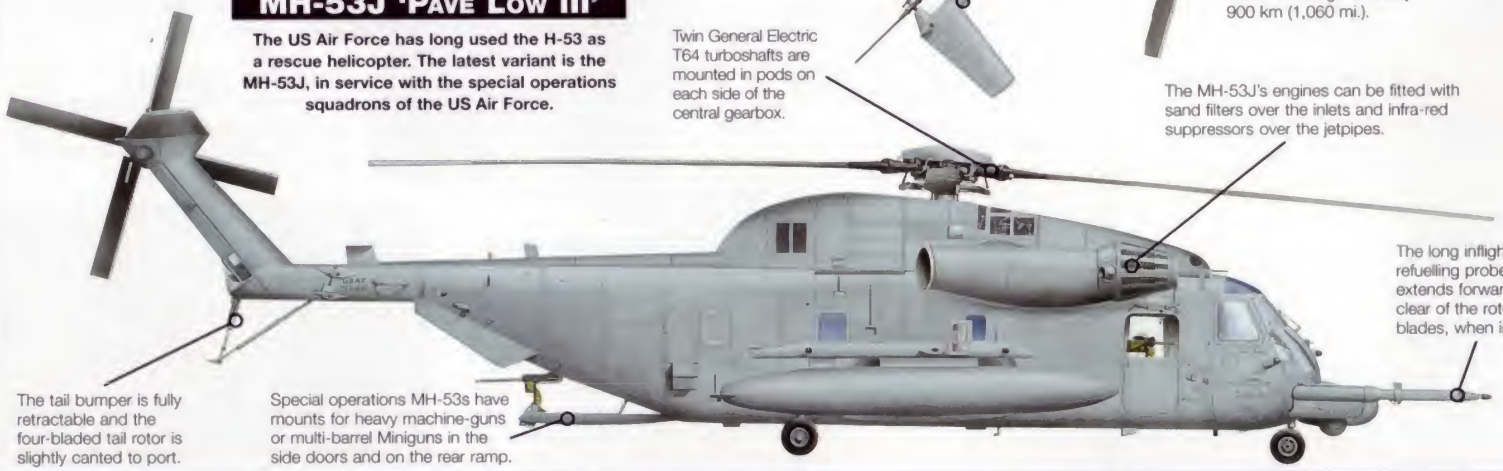
The CH-53 is still used in the aircrew rescue role, and carried out a successful mission in Bosnia.

The US Marine Corps had been strong believers in the value of the helicopter since Korea, and during the Vietnam War it was the Marines who were the inspiration for the largest and most powerful helicopter in the world outside the Soviet Union. From their earliest battles in 1965 they counted on the box-shaped, heavylift S-65 to haul ammunition, troops and supplies from logistics bases right out to the battle area. To the Marines who use air power as an adjunct to ground forces, the S-65 provided a new standard of speed and mobility in battle.

The CH-53A was the only version of the Sikorsky S-65 for some time after the first flight on 11 October 1964. In time, however, others saw the value of the powerful machine. US Navy MH- and RH-53s were used to sweep mines at sea; the US Air Force's HH-53 'Super Jolly' is a dedicated combat rescue machine. Other important operators include Austria, Germany and Israel. The Marines' 'ultimate' twin-engine S-65 was the CH-53D, which has since been supplanted by the much more powerful three-engined CH-53E, which is an entirely new machine.

MH-53J 'PAVE LOW III'

The US Air Force has long used the H-53 as a rescue helicopter. The latest variant is the MH-53J, in service with the special operations squadrons of the US Air Force.



The MH-53J's rotor blades and tailboom have a power folding mechanism, which reduces the time needed to prepare the helicopter for air transport aboard the C-5 Galaxy.

An extensive avionics fit includes terrain-following radar and forward-looking infra-red sensors.

Special forces CH-53s have a crew of four: two pilots and two parajumpers, who act as loadmasters, winchmen, medics and gunners.

The tailboom folds to take up less space on confined carrier decks. The fixed tailplane acts as a stabiliser, providing improved pitch control.

Two external 1703-litre (450-gal.) drop-tanks more than double the MH-53's maximum range to nearly 900 km (1,060 mi.).

Twin General Electric T64 turboshafts are mounted in pods on each side of the central gearbox.

The MH-53J's engines can be fitted with sand filters over the inlets and infra-red suppressors over the jetpipes.

The long inflight-refuelling probe extends forward, well clear of the rotor blades, when in use.

The tail bumper is fully retractable and the four-bladed tail rotor is slightly canted to port.

Special operations MH-53s have mounts for heavy machine-guns or multi-barrel Miniguns in the side doors and on the rear ramp.

CH-53A

Type: twin-engine cargo helicopter

Powerplant: two 2127-kW (2,852-hp.) General Electric T64-GE-3, -6, -6B, or -12 turboshafts driving a six-bladed main rotor

Maximum speed: 305 km/h (189 m.p.h.) at sea level

Range: 870 km (540 mi.)

Weights: empty 10690 kg (23,567 lb.); loaded 18370 kg (40,500 lb.)

Accommodation: 55 troops, 24 stretchers and four attendants, or 3629 kg (8,000 lb.) of cargo loaded through full section rear ramp/doors; US Air Force rescue versions carry up to three 7.62-mm Miniguns

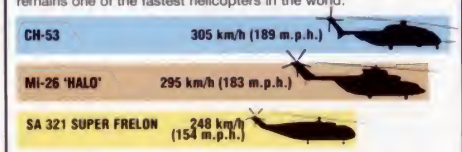
Dimensions:

main rotor diameter	22.02 m (72 ft. 3 in.)
length	20.47 m (67 ft. 2 in.)
height	7.6 m (24 ft. 11 in.)
rotor disc area	378.1 m² (4,070 sq. ft.)

COMBAT DATA

MAXIMUM SPEED

Big helicopters can be fitted with large rotor blades and powerful engines, and tend to be faster than their smaller brethren. The CH-53 is no exception. Even when carrying a heavy load, it remains one of the fastest helicopters in the world.

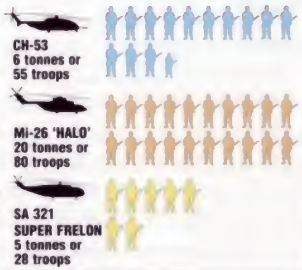


RANGE

Although they cannot match the reach of fixed-wing machines, the CH-53 and its rivals have very long ranges for helicopters. Large size usually means the ability to carry large loads of fuel, which translates into the ability to fly quite long distances.

PAYLOAD

Large helicopters are designed to carry heavy loads. The CH-53 was for many years the West's most powerful helicopter, only replaced by the much modified and more powerful CH-53E. Though it cannot match Russia's giants for sheer lifting ability, the CH-53 is better in a tactical situation, being more agile.

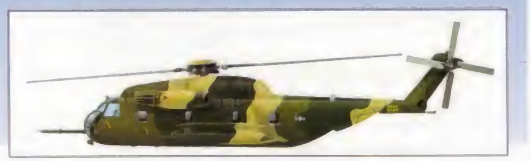


S-65s in service

■ **MARINE ASSAULT:** The CH-53 was designed primarily for the United States Marine Corps, which uses the type as its primary heavylift assault helicopter. Current versions can carry a 9-tonne payload.

■ **GERMAN LOAD-LIFTER:** The largest user of the big twin-engined Sikorsky outside the USA is the German army. The first of a fleet of 112 aircraft, all but two assembled or built by VFW-Fokker, entered service in March 1973.

■ **AIR FORCE RESCUE:** The Sikorsky's size and speed made it ideal for combat rescue, and as the HH-53 it entered service with the US Air Force in Vietnam. Current versions are among the most sophisticated helicopters now flying.



SIKORSKY

UH-60 BLACK HAWK

● Tactical assault helicopter ● First Gulf War transporter

Sikorsky's UH-60 Black Hawk is one of the most important combat helicopters in service today. Replacing the famous Bell Huey as the US Army's workhorse, the UH-60 was designed to haul a squad of 11 fully equipped infantrymen into battle. The same basic airframe has also been developed for special forces, combat rescue, air–sea rescue and anti-submarine operations.

▲ *Carrying troops into battle demands a tough, fast helicopter. The UH-60 entered service in this role at the end of 1979, and has been a great success.*

PHOTO FILE

SIKORSKY UH-60 BLACK HAWK

▲ Squad carrier
The UH-60 can carry a larger squad of soldiers than the UH-1 it replaced, and in much greater comfort and protection.

Troops out ▶
The UH-60's doors are designed to allow an infantry squad to get into action in the minimum possible time.

▲ Air assault
One of the conditions for the bulk of the equipment supplied to the Air Assault divisions of the US Army is that it should be Black Hawk-portable.

▼ Weight lifter
Although designed as a troop carrier, the UH-60 can also carry a significant cargo load both internally and slung on hooks externally.

▼ Medical evacuation
A flying ambulance comes in to land at a desert airstrip, the soldier on the ground guiding the pilot through the fog of rotor-blown sand.

▲ Rope down
Special forces soldiers can abseil down from the UH-60 very quickly. This is useful in tight situations where the pilot cannot land safely.

FACTS AND FIGURES

- The original UH-60A prototype first flew on 17 October 1974.
- Black Hawks entered service with the 101st Airborne Division in 1979.
- Although the US Marine Corps has not adopted the UH-60, it flies nine VH-60N presidential transport helicopters.
- Black Hawks moved more than a million soldiers during the 1991 Gulf War.
- In a tragic 'friendly fire' mishap, F-15 fighters shot down two US Army UH-60s in Iraq on 14 April 1994, killing 26.
- The Army is developing a UH-60Q medical evacuation model of the Black Hawk.

PROFILE

Sikorsky's flying troop-truck

Known to the manufacturer as the Sikorsky S-70, the remarkable UH-60 Black Hawk provides soldiers with speed and mobility in the middle of the action, freeing them from terrain obstacles.

While combat troops enter and leave the battle zone aboard the UH-60, versions of the helicopter carry out electronic warfare duties, fight with special operations forces, or perform ambulance or VIP transport duties.

Pilots in the UH-60 have excellent visibility and armour protection as they fly in and out of landing zones. An exhaust suppression system reduces their vulnerability to heat-seeking battlefield missiles.

The UH-60 fought in Grenada, Panama, Iraq and Afghanistan, and appears little changed after more than two decades of Army duty. In fact, the UH-60 has been continuously upgraded with more powerful engines and other improvements. The latest UH-60L has the power to lift a military Hum-Vee tactical vehicle loaded with TOW anti-tank missiles.

The UH-60 was designed with all the years of experience of battle in Vietnam in mind. The low profile of the airframe makes it a difficult target, and safer if it crashes.

As a precaution against battle damage, the UH-60's engines are as widely spaced as possible.

The UH-6's rotor system features swept tips, giving enhanced performance and allowing heavy loads to be lifted in 'hot and high' conditions.

The fuselage plan is noticeably broad and long, giving a generous internal capacity while allowing a very flat profile.

UH-60A Black Hawk

The UH-60A, the first of many versions of the Black Hawk family, saw action during the invasion of Grenada in 1981. The Black Hawk has since been in action in Lebanon, Somalia and the Gulf War.

The UH-60's rotor-head and blades were designed to withstand hits from large machine-gun rounds. The gearbox that drives it can run for half an hour after losing its entire oil supply.

The transparent panels in the nose are essential for safe landing in confined spaces.

The Black Hawk has an exhaust suppression system which dissipates hot engine gases. This makes the helicopter less of a target for heat-seeking infra-red missiles.

In an assault landing, the UH-60 comes in fast. Its undercarriage is designed to absorb vertical impacts of up to 45 km/h (28 mph).

Although the Black Hawk can carry armament, it is essentially a troop carrier. Its cabin and hatches are designed to allow a squad of infantry to get into action fast.

Sikorsky's designers intentionally built the tail rotor at an angle. This design feature means that lift is generated at the tail, allowing heavier loads at the rear of the cabin than would otherwise be possible.

UH-60A Black Hawk

Type: utility helicopter

Powerplant: two 1261-kW (1,691-hp) General Electric T700-GE-700, -701 or -401 turboshafts

Maximum speed: 296 km/h (184 mph)

Range: 600 km (373 miles)

Weights: (Army UH-60) empty 4819 kg (10,624 lb); loaded 9185 kg (20,249 lb). (Navy SH-60) empty 6191 kg (13,649 lb); loaded 9926 kg (21,883 lb)

Armament: usually two 7.62-mm (0.3-in) door guns

Dimensions:

rotor diameter	16.36 m (53 ft 8 in)
length	19.76 m
height	5.13 m
rotor disc area	210.10 m² (2,261 sq ft)

COMBAT DATA

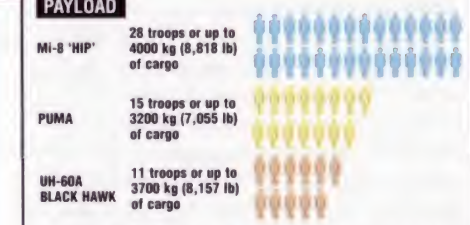
RANGE

The Mi-8's greater size and fuel-carrying capacity give it an advantage over the Black Hawk when operating on internal fuel only. But the UH-60 can be fitted with stub wings, onto which can be mounted weaponry or external fuel tanks. With four tanks fitted, the efficient Sikorsky helicopter has a ferry range of more than 2000 km (1,240 miles).

MAXIMUM SPEED

The Black Hawk's powerful engines and slender aerodynamic cross-section make it one of the fastest helicopters around. It is quicker than most of its rivals, and this, allied to its great agility, makes it a superb platform for mounting helicopter assaults.

PAYLOAD



Although the UH-60 is nominally an 11-seater, it can carry up to 20 troops in an emergency. The Black Hawk has enough power to lift the same kind of loads as its bigger Russian and European rivals, yet retains the agility of a much smaller machine.

Airborne helicopter assault in the 1991 Gulf War

GULF DEPLOYMENT: The Black Hawk was the most numerous helicopter in the Gulf, with over 350 serving with major US Army formations.

LOW-LEVEL FLIGHT: The biggest users of UH-60s were the 1st Cavalry Division and the 82nd and 101st Airborne divisions.

COALITION SPEARHEAD: Black Hawks were at the forefront of the Coalition offensive, taking spearhead troops deep into Iraqi-held territory.

SADDAM DEFEATED: By attacking in helicopters, elite US Army airborne troops were able to outflank Iraq's battlefield defences.

SUD-OUEST

VAUTOUR

● 1950s all-weather fighter and bomber ● In action with Israel

Sud-Ouest's Vautour was a versatile twin-jet produced in both single-seat and two-seat versions. For several years after entering service in 1956 it was France's only all-weather fighter, and it remained operational in this role until 1973. There were also light bomber and strike versions. The only other operator was the Israeli air force, which used the Vautour during the 1967 Six-Day War against Egypt, Iraq, Jordan and Syria.

▲ *Although ordered in large numbers by the French air force, only 140 were delivered and a significant proportion of these ended up in Israel. Like Britain and Canada, France chose to build its own all-weather fighter rather than buy American F-86 Sabres.*

PHOTO FILE

SUD-OUEST VAUTOUR

Radar testing ▶
This two-seat Vautour found a new lease of life as the testbed aircraft for the Thomson-CSF RDM Cyrano 500 radar fitted to the Mirage 2000.

▼ Second prototype
The second Vautour, S.O.4050-02, was completed as a single-seat, ground-attack aircraft powered by two Atar 101D turbojets. It first flew on 16 December 1963.

▲ Vautour IIB bomber
The bomber version of the Vautour was a two-seater, with the pilot sitting under the canopy, as in the IIA ground-attack version, but with his bomb-aimer positioned on a seat in the transparent nose of the aircraft.

▲ Brand-new Vautour IIA
This early aircraft clearly shows the tandem main undercarriage and the engine nacelle-mounted outriggers.

◀ Underwing stores
Two pylons on each wing could be used to carry bombs, rockets or fuel drop-tanks.

FACTS AND FIGURES

- Pre-production Vautours were built with Rolls-Royce Avon and Armstrong Siddeley Sapphire engines.
- French air force Vautours have also been used as air-to-air refuelling tankers.
- Only 30 of 300 French air force Vautour IIAs originally ordered were built.
- When it entered service in 1956 the Vautour IIN was the Armée de l'Air's only all-weather/night fighter.
- The first Vautour was fitted with engines producing 23.54 kN (5,294 lb thrust) each.
- Vautours were produced by Sud-Ouest for three years from 1956 to 1959.

PROFILE

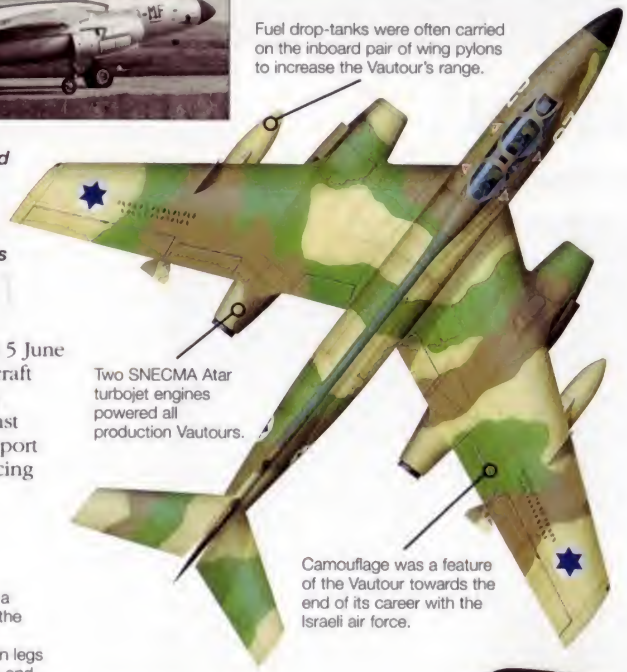
Versatile 1950s fighter-bomber

France's aircraft industry recovered remarkably well after World War II. Together with the Dassault series of jets came new military aircraft from the national aircraft industry, among them being Sud-Ouest's S.O.4050 Vautour.

The first version to fly, in 1952, was the IIN all-weather/night fighter. It carried a radar in the nose, four 30-mm (1.18-in) cannon or 240 air-to-air rockets in the forward fuselage and additional rockets or missiles under the wings. Next came the IIA, a single-seat, ground-attack aircraft armed with four cannon and up to six 450-kg (992-lb) bombs carried internally. The IIB was a two-seat bomber. It carried no guns, but had a glazed nose for bomb aiming. Some were modified as IIBR reconnaissance bombers.

Israel bought up to 25 IIAs together with a number of IINs in 1960. These were used in combat during the Six-Day War. After taking part in pre-emptive strikes against airfields on 5 June that left 309 Egyptian aircraft destroyed on the ground, Vautours were used against targets in Iraq and to support the ground troops advancing towards the Suez Canal.

The Armée de l'Air retained their Vautour IINs until 1973, when they started to be replaced by Mirage F.1Cs. This example carries the markings of 30e Escadre de Chasse.



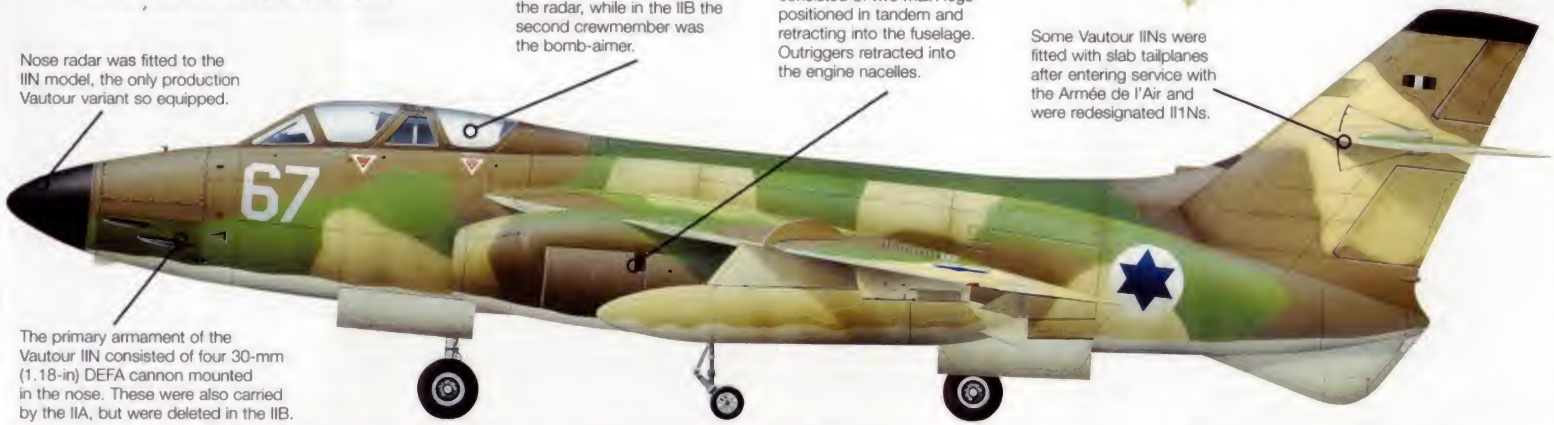
Fuel drop-tanks were often carried on the inboard pair of wing pylons to increase the Vautour's range.

Two SNECMA Atar turbojet engines powered all production Vautours.

Camouflage was a feature of the Vautour towards the end of its career with the Israeli air force.

VAUTOUR IIN

One of five Vautour IIN night fighters exported to Israel in 1960, '67' may have been among a number of Israeli Vautours converted for an electronic countermeasures role later in its career.



Nose radar was fitted to the IIN model, the only production Vautour variant so equipped.

All crew positions were pressurized and equipped with ejection seats. In the IIN the backseater operated the radar, while in the IIB the second crewmember was the bomb-aimer.

As the Vautour used a high-mounted wing, the main undercarriage consisted of two main legs positioned in tandem and retracting into the fuselage. Outriggers retracted into the engine nacelles.

Some Vautour IINs were fitted with slab tailplanes after entering service with the Armée de l'Air and were redesignated II1Ns.

The primary armament of the Vautour IIN consisted of four 30-mm (1.18-in) DEFA cannon mounted in the nose. These were also carried by the IIA, but were deleted in the IIB.

Vautour IIA

Type: single-seat ground-attack fighter

Powerplant: two 34.32-kN (7,719-lb-thrust) SNECMA Atar 101E-3 turbojet engines

Maximum speed: 1105 km/h (687 mph)

Maximum climb rate: 3600 m/min (11,811 fpm)

Range: 2575 km (1,600 miles)

Service ceiling: over 15,000 m (49,210 ft)

Weights: empty 10,000 kg (22,046 lb); maximum take-off 20,000 kg (44,092 lb)

Armament: four DEFA 30-mm (1.18-in) cannon, up to 240 rockets or 10 bombs in the fuselage bomb-bay, 76 MATRA M.116E rockets or 24 120-mm (4.72-in) rockets or two 450-kg (992-lb) bombs

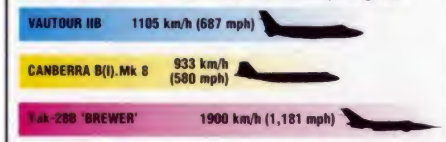
Dimensions:

span	15.09 m (49 ft 6 in)
length	15.57 m (51 ft 1 in)
height	4.50 m (14 ft 9 in)
wing area	45.00 m² (484 sq ft)

COMBAT DATA

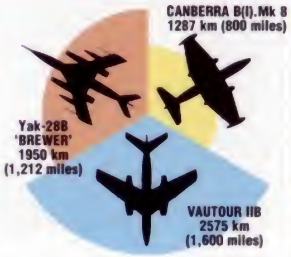
MAXIMUM SPEED

The Vautour and the Canberra had excellent speeds for the mid-1950s when they entered service, and both could also climb to an impressive altitude. The later Yak-28, however, was a far quicker interdictor with its powerful RD-11 turbojet engines.



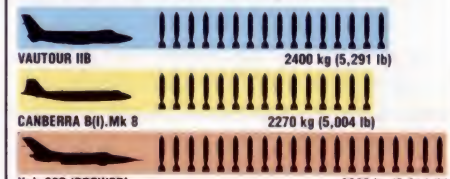
RANGE

As air-to-air refuelling was in its infancy during the late 1950s range was especially important. Both the Vautour and the Yak-28 had good reach, but this was noticeably reduced when a full load of bombs was carried. The Canberra could not match the range of its rivals.



BOMBLOAD

The Vautour and the Canberra could both carry a similar weight of bombs. The Canberra was highly versatile and was equipped with four cannon and had the ability to carry nuclear weapons. The Vautour was often employed in the ground-attack role.



The Six-Day War

'BADGERS' ON THE GROUND: In the opening hours of the war, Israel launched pre-emptive strikes against neighbouring states, including Egypt where Soviet-built Tu-16s were caught on the ground.

TANKS IN THE SINAI DESERT: Vautours were also used tactically in support of ground forces. Major tank battles between Israel and Egypt took place in the Sinai Desert, with Vautours making bombing runs over enemy tank columns.

CAUGHT BY A HUNTER: Vautours were vulnerable to fighter attack. This aircraft succumbed to a Hunter of the Jordanian air force.

SUKHOI

SU-15 'FLAGON'

● Supersonic ● Twin-jet interceptor ● Delta-winged fighter

▲ *A high-performance interceptor fighter built to replace the Sukhoi Su-11, the more powerful Su-15 was first revealed to the public at the 1967 Soviet Aviation Day in Moscow.*

Sukhoi developed the Su-15 as a response to the threat from projected American bombers. Equipped with a high standard of avionics for automated interceptions with long-range missiles, the Sukhoi Su-15 was progressively upgraded, receiving new wings, engines, optional cannon pods and improved radar. Less well-known than rival MiGs, the Su-15 is now infamous for destroying a Korean Boeing 747.

PHOTO FILE

SUKHOI SU-15 'FLAGON'

▼ STOL research
This Su-15VD short take-off and landing version had three additional lift engines in the fuselage.

▲ Modified delta
Production Su-15s had a redesigned outer wing, with the leading edge reduced to 45° and greater span.

Missiles ▶
The Su-15's nose radar was used for long-distance auto-interceptions and firing of underwing air-to-air missiles.

▼ Twin turbojet
With a large diameter nose radar, the Su-15's two afterburning R-11F2SU-300 turbojets had side fuselage air intakes. These were canted outwards and raked back in plan view.

▲ Fighter cockpit
The Su-15 was equipped for all-weather operation, including SAU-58 autopilot, an Iskra-K blind-landing system and 'Taifun' interception radar.

FACTS AND FIGURES

- An exceptionally 'clean' fighter, the Su-15 could climb to 11 km (6.8 miles) at combat weight in 2½ minutes.
- The Su-15 was developed to counter the USAF bomber threat in the early 1960s.
- The first public showing was by a Soviet air force aerobatic team in 1967.
- The very long nose probe of the 'Flagon' housed pitch and yaw transducers which provided data for a fire-control computer.
- Su-15s shot down a KAL Boeing 707 in April 1978 and a 747 in September 1983.
- A dual trainer (Su-15UM) had a second cockpit in place of the No. 1 fuel tank.

PROFILE

Sukhoi's deadly 'Flagon'

Designed to fully meet the demanding requirement for an all-weather interceptor that would be able to remain operational in the most adverse conditions, the Sukhoi Su-15 was a conventional interceptor. The Sukhoi Design Bureau decided not to adopt a variable geometry wing, which was internationally favoured at that time. Instead, the Su-15 emerged as a needle-nosed single-seater incorporating some 'tried and tested' systems and equipment, including Tumanskii engines. The radar was new, as were the intended weapons.

Flight-testing of the Su-15 began in 1964, but a lengthy development period delayed its Soviet air force service debut until the early 1970s. The type was given the NATO reporting code name 'Flagon'. Among the variants that emerged were the Su-15UM tandem two-seat trainer ('Flagon-C') and the Su-15VD, with additional lift engines. Three of these were installed in the rear fuselage to provide data on V/STOL performance.

A compound delta wing was used on the principal interceptor version, the Su-15 'Flagon-D'. Armed with both missiles and guns, it was capable of a maximum 'dash' speed of Mach 2.59. Two final versions, designated 'Flagon-E' and 'F', also entered service.

The first prototype Su-15 was rebuilt for STOL research. It had a modified wing and three additional engines; one was in the forward bay, with two in tandem to the rear. It was first flown in 1966.

Su-15TM 'Flagon-F'

Type: all-weather interceptor fighter

Powerplant: two Tumanskii R-11 F2SU-300 turbojets giving 78.00 kN (17,196 lb thrust) (112.00 kN/24,692 lb thrust with afterburner)

Maximum speed: 2230 km/h (1,385 mph) at 13000 m (42,750 ft)

Range: 1380 km (860 miles)

Service ceiling: 16600 m (55,000 ft)

Weights: empty 10874 kg (24,000 lb); loaded 17194 kg (37,900 lb); maximum 17660 kg (38,900 lb)

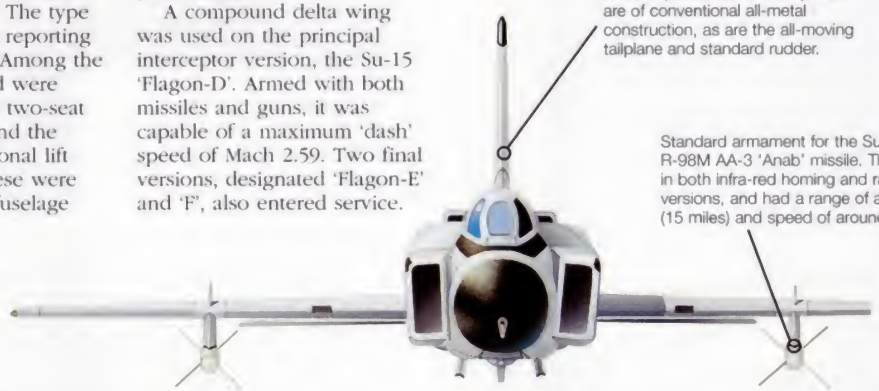
Armament: four wing hardpoints for two R-98M and two R-60T AAMs and two underfuselage UPK-23-250 gun pods

Dimensions:

span	9.34 m (30 ft 8 in)
length	20.54 m (67 ft 5 in)
height	5.79 m (19 ft)
wing area	36.6 m² (394 sq ft)

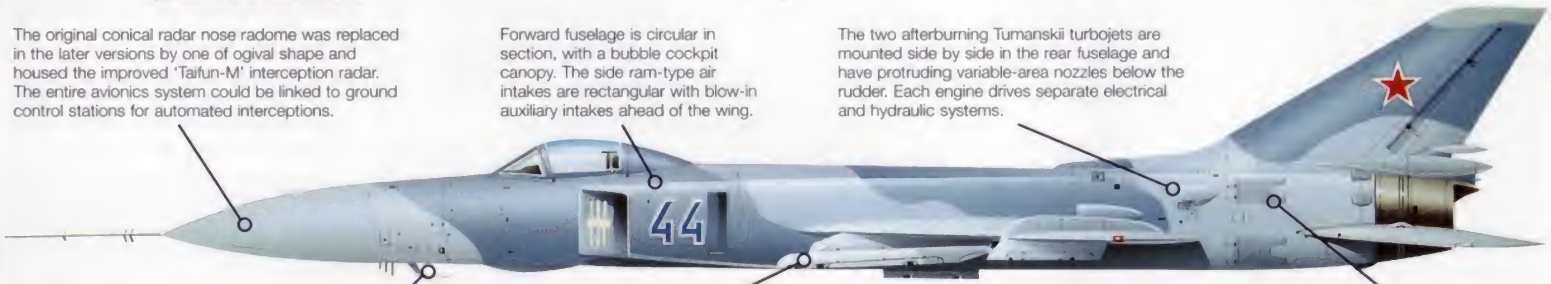
Su-15TM 'Flagon-F'

The twin-turbojet, delta-winged Su-15 was first flown on 30 May 1962. It took nearly 10 years of development before it was fully operational as an all-weather air-defence fighter. More than 1500 had been built when production ended in 1979.



The swept-back fin and tailplane are of conventional all-metal construction, as are the all-moving tailplane and standard rudder.

Standard armament for the Su-15 was the R-98M AA-3 'Anab' missile. This was used in both infra-red homing and radar versions, and had a range of around 24 km (15 miles) and speed of around Mach 2.5.



The original conical radar nose radome was replaced in the later versions by one of ogival shape and housed the improved 'Taifun-M' interception radar. The entire avionics system could be linked to ground control stations for automated interceptions.

Forward fuselage is circular in section, with a bubble cockpit canopy. The side ram-type air intakes are rectangular with blow-in auxiliary intakes ahead of the wing.

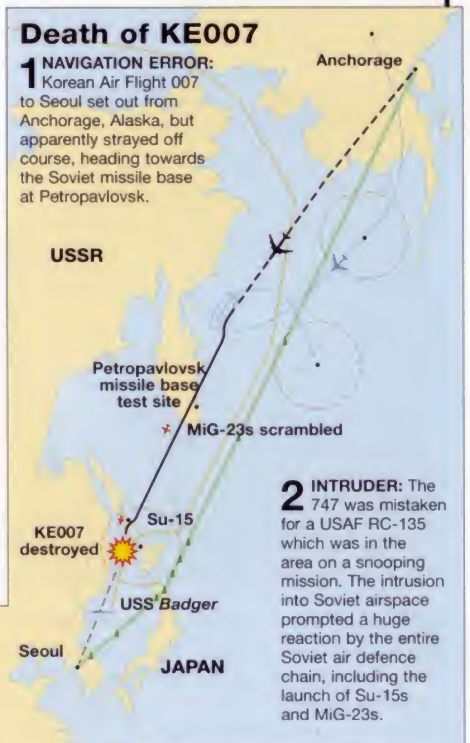
The two afterburning Tumanskii turbojets are mounted side by side in the rear fuselage and have protruding variable-area nozzles below the rudder. Each engine drives separate electrical and hydraulic systems.

The aircraft had a tricycle-type undercarriage with single wheels on each leg. The nosewheel retracts forwards and the mainwheels retract inwards into the wings.

Underwing external stores were carried by a single pylon on early versions and two pylons on later 'Flagons'. To supplement the AA-3 missile, four infra-red close-range R-60 AA-8 'Aphid' air-to-air missiles could also be fitted on twin PD-62 pylons. There is provision for UPK gun pods under the fuselage.

Rectangular, door-type air brakes were fitted, one on each side of the fuselage, forward of the tailplane.

Death of KE007



1 NAVIGATION ERROR: Korean Air Flight 007 to Seoul set out from Anchorage, Alaska, but apparently strayed off course, heading towards the Soviet missile base at Petropavlovsk.

2 INTRUDER: The 747 was mistaken for a USAF RC-135 which was in the area on a snooping mission. The intrusion into Soviet airspace prompted a huge reaction by the entire Soviet air defence chain, including the launch of Su-15s and MiG-23s.

3 SHOOT DOWN: After an unsuccessful attempt by two MiG-23s, an Su-15 acquired the target. Despite numerous radio calls to the 747, the aircraft continued on towards the Soviet Union's most important military bases on Sakhalin Island. Finally, the Su-15 pilot fired AA-3 missiles and destroyed KAL Flight 007, killing more than 260 passengers.

Key

- Area of Soviet airspace
- Limit of remote-control air-to-ground beacon
- Normal route for KAL flight
- Airway reporting points
- Flight path of KE007
- Supposed flight path after shoot-down
- Alleged flight path of the USAF's RC-135

COMBAT DATA

MAXIMUM SPEED

The Su-15's powerful twin R-13 turbojet engines propel the Su-15 well beyond Mach 2. Most jets of the 1960s era have an excellent turn of speed, but tend to lack the manoeuvrability of today's superfighters.

RANGE

All three aircraft were designed as interceptors to be used against attacking high-level bombers. Although they possessed respectable range for the 1960s, the use of afterburner drastically reduced their range. The use of airborne refuelling was important for longer range interception.

ARMAMENT

Standard armament for the later versions of the 'Flagon' was two medium-range and four short-range missiles. Like many 1960s fighters an integral cannon was omitted from the design, but the Su-15 often carried two 23-mm (0.91-in) GSh-23L cannon pods under the fuselage. The F-106 housed its weapons in an internal bay, allowing it to retain its aerodynamic shape.

SUKHOI

SU-24 'FENCER'

● Low-level strike ● Electronic warfare ● Nuclear bomber

Fast, long-ranged and deadly accurate, the Su-24 'Fencer' was the first Soviet warplane with an avionics system which integrated navigation, bombsight and weapons control via a central computer. An advanced swing-wing bomber, the Su-24 could mount high-speed nuclear strikes deep into NATO territory from far behind the Iron Curtain. The Su-24 also proved its high-level bombing capability during operations over Afghanistan.

▲ *From bases in Poland or East Germany, the Su-24 could have hit air bases in eastern Britain. The huge increase in capability introduced by this aircraft caused NATO planners considerable headaches.*

PHOTO FILE

SUKHOI SU-24 'FENCER'

◀ Reconnaissance bird
The Su-24MR is equipped with advanced cameras and infra-red systems for the reconnaissance role. Electronic sensors can also be carried in pods.

▼ Wings forward
With its broad wings forward, the Su-24 can land at a sedate 230 km/h (143 mph). It has full-span flaps and a slotted leading edge for low-speed flight.

▼ Afghan bomber
The 'Fencer' first saw action in Afghanistan, flying long-range strikes in the Panjshir Valley from bases in the Soviet Union.

▲ Anti-ship missile
Long-range naval strike missions were another Su-24 speciality. This aircraft is armed with the lethal AS-11 'Kilter' missile, which has a 150-kg (330-lb) warhead.

'Fencer-E' ▶
The reconnaissance 'Fencer-E' has dielectric panels on the nose sides. These cover the Shtik side-looking radar system, which has a moving target indicator and can be used to produce maps.

FACTS AND FIGURES

- The 'Fencer' was derived from a prototype that first flew in June 1967.
- The Su-24 entered squadron service in 1974 and appeared outside the Soviet Union in 1979.
- The Su-24 was the first aircraft with the superb Severin K-36D ejection seat.
- About 700 'Fencers' of all versions have been manufactured.
- The reconnaissance 'Fencer-E' can use its cameras at 150–2000 m (492–6,562 ft) and at speeds of 600–1200 km/h (373–746 mph).
- The Su-24 used laser-guided bombs to destroy bridges in Chechnya.

PROFILE

Sukhoi's long-armed striker

With side-by-side seating for its two-man crew and variable-geometry wings which can be swept back for high-speed flight, the powerful Su-24 has often been compared with the larger General Dynamics F-111. Like the American jet, the 'Fencer' is a long-range strike aircraft, but it also exists in reconnaissance and electronic warfare versions.

Improved Su-24s now in service make extensive use of smart weapons technology, including laser and TV designator/tracker systems. Like the F-111 and the smaller Tornado, the 'Fencer' can fly virtually all of a typical combat mission at treetop altitude, evading enemy radar and air defences and attacking with remarkable accuracy. Some versions of the 'Fencer' add in-flight refuelling capability, giving them strategic range.

Ironically, while the US Air Force is retiring the F-111 for economy reasons, the Sukhoi Su-24 is employed more widely than ever, as the forces of the former USSR are struggling to fund a replacement. This will probably be Sukhoi's Su-27IB strike fighter.

Seen here over the Baltic from a Swedish fighter, the 'Fencer' is a formidable machine. The loss of most Su-24s to other republics is keenly felt by the Russian forces.

'Fencer' has a twin nosewheel to allow operation from short unpaved runways at high all-up weights. A large mudguard is fitted behind the wheels to prevent the engines from ingesting snow.

The first 'Fencers' had a 30-mm (1.18-in) cannon in the lower starboard fuselage, but this is replaced by cameras in the 'Fencer-E'.

Su-24 'Fencer-C'

Powerplant: two NPO Saturn (Lyul'ka) AL-21F-3A turbojets each rated at 76.49 kN (17,204 lb thrust) dry and 110.33 kN (24,814 lb thrust) with afterburning

Maximum speed: 2320 km/h (1,442 mph) at 11,000 m (6,835 ft)

Combat radius: 1050 km (652 miles) with full weapons load

Service ceiling: 17,500 m (57,415 ft)

Weights: empty 19,000 kg (41,888 lb); loaded 36,000 kg (79,366 lb)

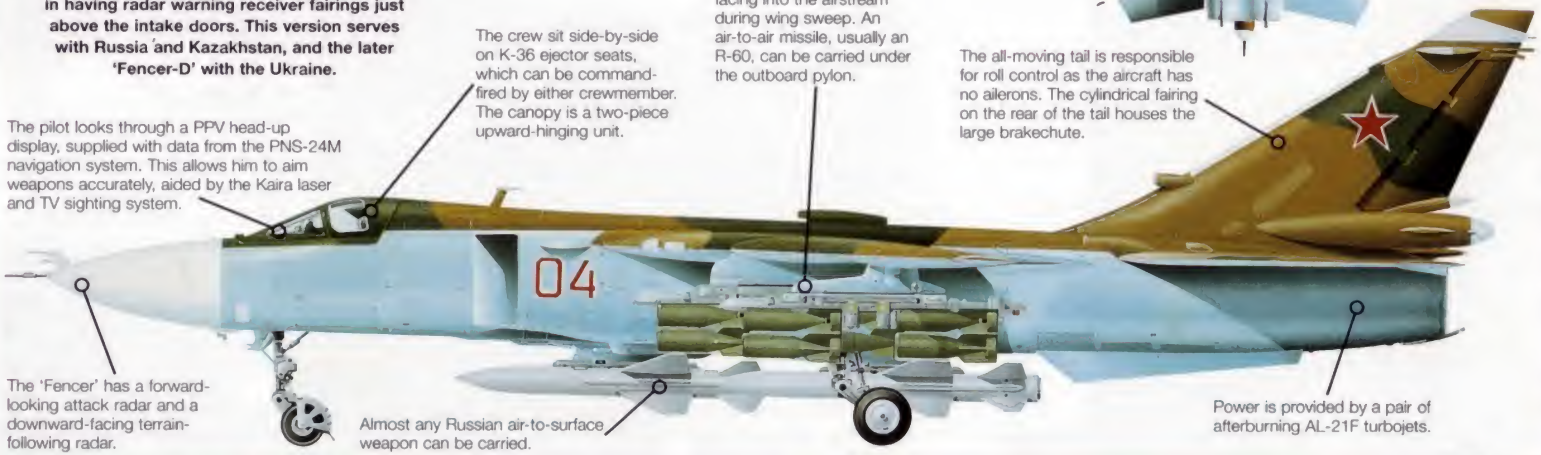
Armament: one GSH-6-23m 23-mm cannon; provision for TN-1000 and TN-1200 nuclear bombs or for up to 8800 kg (19,400 lb) of conventional bombs and missiles

Dimensions:

span (spread)	17.63 m (57 ft 10 in)
span (swept)	10.36 m (34 ft)
length	24.53 m (80 ft 6 in)
height	6.19 m (20 ft 4 in)
wing area	42.00 m² (452 sq ft)

SU-24 'FENCER-C'

The 'Fencer-C' differed from the earlier 'Fencer-B' in having radar warning receiver fairings just above the intake doors. This version serves with Russia and Kazakhstan, and the later 'Fencer-D' with the Ukraine.



The pilot looks through a PPV head-up display, supplied with data from the PNS-24M navigation system. This allows him to aim weapons accurately, aided by the Kaira laser and TV sighting system.

The crew sit side-by-side on K-36 ejector seats, which can be command-fired by either crewmember. The canopy is a two-piece upward-hinging unit.

Outboard pylons can swivel to keep the wing stores facing into the airstream during wing sweep. An air-to-air missile, usually an R-60, can be carried under the outboard pylon.

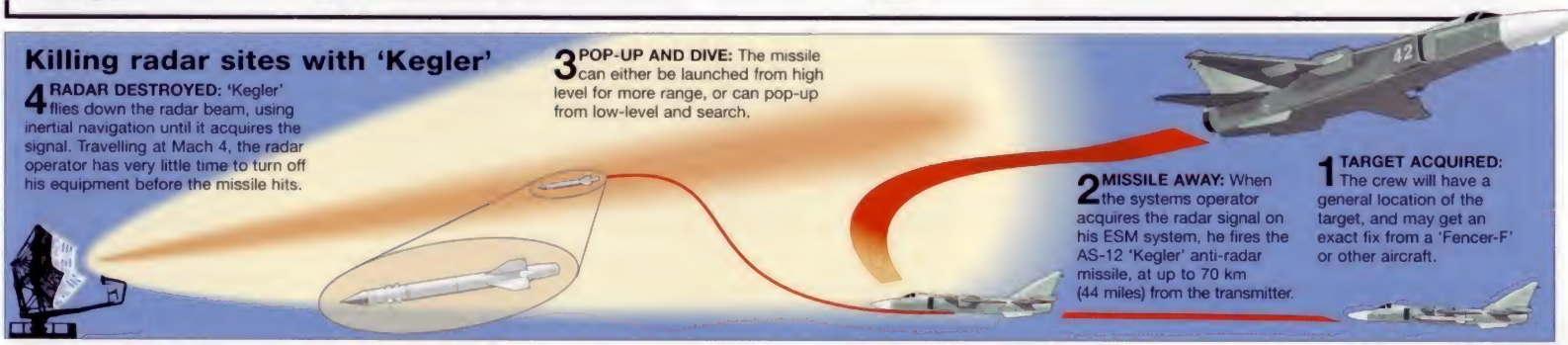
The all-moving tail is responsible for roll control as the aircraft has no ailerons. The cylindrical fairing on the rear of the tail houses the large brakechute.

The 'Fencer' has a forward-looking attack radar and a downward-facing terrain-following radar.

Almost any Russian air-to-surface weapon can be carried.

Power is provided by a pair of afterburning AL-21F turbojets.

Killing radar sites with 'Kegler'



1 TARGET ACQUIRED: The crew will have a general location of the target, and may get an exact fix from a 'Fencer-F' or other aircraft.

2 MISSILE AWAY: When the systems operator acquires the radar signal on his ESM system, he fires the AS-12 'Kegler' anti-radar missile, at up to 70 km (44 miles) from the transmitter.

3 POP-UP AND DIVE: The missile can either be launched from high level for more range, or can pop-up from low-level and search.

4 RADAR DESTROYED: 'Kegler' flies down the radar beam, using inertial navigation until it acquires the signal. Travelling at Mach 4, the radar operator has very little time to turn off his equipment before the missile hits.

Su-24 WEAPONS

AA-8 (R-60) MISSILE

The R-60 missile is a short-range infra-red homing weapon. The Su-24 usually carries at least one of these under the wing for self-defence against enemy fighters.

FAB-500 BOMB

The FAB-500 is the standard general-purpose Russian free-fall bomb. It is filled with 214 kg (472 lb) of Torpex high-explosive, detonated by various types of fuses.

S-24 ROCKET

Designed to destroy large fixed installations such as aircraft shelters and missile launchers, the S-24 is unusual in that it relies only on fins for guidance. The weapon has a very powerful warhead. It is also carried by MiG-29 and Su-30 fighter-bombers.

TUPOLEV

TU-4 'BULL'

● Post-war strategic bomber ● Chinese-built turboprop versions

By the second half of 1944, when three US B-29 bombers landed at Vladivostok after running low on fuel, the Tupolev design bureau was already working on an equivalent to the Superfortress. The United States had refused to supply its latest bomber to the Soviet Union, so the three examples were dismantled and analysed. It then took more than 1000 draughtsmen to prepare plans to build a direct copy of the aircraft.

▲ *A direct copy of the United States' own B-29 Superfortress, the Tu-4 was based on three B-29s which crash-landed in the eastern Soviet Union, only to be restored and flown to Moscow for study.*

PHOTO FILE

TUPOLEV Tu-4 'BULL'

◀ Chinese AWACS
In China about 20 Tu-4s were used in the bombing, airborne early warning and drone launching/directing roles.

▼ Prototype 'Bull'
The first Tu-4, then known as the B-4, took to the air on 19 May 1947 flown by N. Rybko.

▲ Reconnaissance version
The Tu-4R variant carried fuel in its forward bomb-bay, and cameras in the rear bay for strategic photographic missions.

◀ Weapons fit
Tu-4s carried Soviet weapons, comprising five 23-mm (0.91-in) twin NS-23 gun turrets and modifications to allow 8000 kg (17,637 lb) of free-fall bombs.

Powerplants ▶
The basic Tu-4 had primitive ASh-73TK engines. This drone-carrying Chinese aircraft uses AI-20 turboprops. In Russia, Tu-4LI flying laboratories tested engines for the Tu-95 and Il-18.

FACTS AND FIGURES

- Prior to building the Tu-4 as Stalin ordered, Tupolev had planned its own strategic bomber, 'Project 64'.
- In copying the B-29, Tupolev converted 105,000 parts to metric sizing.
- Production of the 'Bull' ended in 1951, with around 900 eventually built.
- The Tu-4N tanker variants tested numerous types of refuelling system, typically flying with 'probed' MiG-17s.
- A single Tu-4 was converted into the Tu-4T assault aircraft for 28 paratroops.
- The Tupolev OKB proposed a turboprop version, to be known as the Tu-94.

PROFILE

Tupolev's own Superfortress

Starting in January 1945, it took Tupolev nearly two years and 20 prototypes to prepare the Tu-4 for production. Deliveries of the Tu-4 started in 1948, and the type remained in service as a bomber until the late 1950s. Surviving examples were then used as tankers, radar trainers and transport aircraft.

Developments of the basic Tu-4 included the Tu-80 and Tu-85 bombers. The single Tu-80 had increased fuel capacity and low-drag gun turrets, while the much bigger Tu-85, first flown in January 1950, could carry still more fuel and had more powerful engines for a range of 13,000 km (8,078 miles). Only two were built.

There were also one-off transport prototypes with new, circular-section fuselages. The Tu-70 was designed as a 72-passenger airliner, while the Tu-75 was intended to carry troops or military hardware.

The 'Bull' was also supplied to China, and in the late 1990s a few Tu-4s were believed to remain in Chinese service.

Above: Equipped with Kobalt blind bombing radar and powered gun turrets, the 'Bull' was the Soviets' first truly modern bomber aircraft.

Re-engined with Zhuzhou WJ-6 turboprops, they are used as drone carriers and equipment testbeds. A few were fitted with radar for the airborne early warning and control role.

Below: This Chinese drone-carrying Tu-4 was used for cruise missile tests, launching MiG-15-based KS-1s, La-17s and captured German V-1s.

Tu-4 'Bull'

Type: four-engined, long-range strategic bomber

Powerplant: four 1320-kW (1,770-hp) Shvetsov ASh-73TK air-cooled piston engines

Maximum speed: 558 km/h (347 mph) at 10,000 m (32,808 ft)

Initial climb rate: 5000 m (16,404 ft) in 18.2 min

Range: 5100 km (3,169 miles) with 2000-kg (4,409-lb) bombload

Service ceiling: 11,200 m (36,745 ft)

Weights: empty 35,270 kg (77,757 lb); maximum take-off 54,500 kg (120,152 lb)

Armament: ten 23-mm (0.91-in) NS-23 cannon, plus up to 8000 kg (17,637 lb) of bombs

Dimensions:

span	43.05 m (141 ft 3 in)
length	30.18 m (99 ft)
height	8.95 m (29 ft 4 in)
wing area	161.70 m² (1,741 sq ft)

Tu-4 'Bull'

This Tu-4, 'Red 01', is currently preserved at the Monino aerospace museum near Moscow. It seems likely it was one of the first to be built, possibly from the pre-production batch of 20 ordered in 1945.

Produced more quickly than the Tu-4, the Tu-70 VIP passenger transport utilized the entire wings and engines of a captured B-29. This aircraft ultimately had a fuselage holding a crew of six and 72 seats. It had the service designation Tu-12.

Tu-4 pilots found they had some difficulty with internal cockpit reflections and optical distortion as a result of the glazed forward fuselage. The original restored B-29s were flown to Moscow by test pilots Reydel and Marunov. Tupolev fitted its own Soviet VHF radio and IFF (Identification Friend or Foe) to the 'Bull'.

Power for the Tu-4 'Bull' was provided by four ASh-73TK engines each with TK-19 turbochargers and 5-m (16-ft 5-in) diameter VZV-A5 propeller units.

The definitive production defensive armament fit for the 'Bull' was five powered turrets each with two 23-mm (0.91-in) twin-barrelled NS-23 cannon. Those turrets mounted above and below the fuselage were remotely controlled; the tail position was manned.

Unlike the B-29, it seems that the 'Bull' was never equipped to carry nuclear weapons, but its two bomb-bays were able to carry a useful load of up to 8 tonnes (8.8 tons) of conventional bombs.

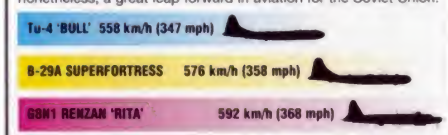
Between the two large bomb-bays was a retractable Kobalt blind bombing radar, which was fitted to the Tu-4 from 1948. At the same time, the early Tu-4s were retrofitted with new gun turrets.

Original production included the 'reconnaissance dedicated' Tu-4R with no offensive weapons, an increased fuel load for long-range missions, and a camera group fitted in the rear bomb-bay.

ACTION DATA

MAXIMUM SPEED

Tupolev's 'Bull' was unable to match the high performance of its inspiration, the American Boeing B-29. Unlike the Tu-4 and the Renzan, the Superfortress saw much active service during the war. Let down in terms of speed by its inferior engines, the Tu-4 was, nonetheless, a great leap forward in aviation for the Soviet Union.



RANGE

The hastily prepared Nakajima Renzan from Japan could not match the range of the Tu-4 or the Boeing B-29. The Tu-4's range was increased greatly after initial flight testing, when internal tankage was increased from a 3480 kg (7,672 lb) to 11,300 kg.(24,912 lb).

SERVICE CEILING

Surprisingly, the Tu-4 had a greater altitude capability than the Boeing Superfortress. This made it an ideal reconnaissance platform and flying laboratory. However, with a full load of 16 500-kg (1,100-lb) bombs, the type's operational ceiling and range would both decrease.

Tupolev's Superfortress derivatives

■ **Tu-70 'CART':** The Tu-70 pressurized VIP passenger transport flew six months before the Tu-4. One aircraft was used by high-ranking Soviet air force (VVS) officials.

■ **Tu-75 'CART':** Entirely Soviet-built, the sole Tu-75 unpressurized military transport featured 50 per cent more fuel capacity, folding seats for up to 120 troops and a cargo ramp/conveyor.

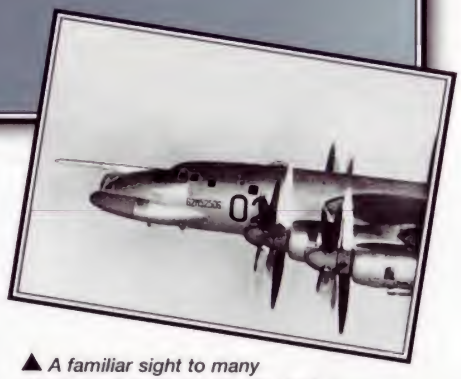
■ **Tu-80:** An attempt at improving the B-29, 1949's Tu-80 had modified gun turrets and was comparable to the US B-50, with a communication tunnel and 12000-kg (26,500 lb) bombload.

■ **Tu-85 'BARGE':** Succeeding the Tu-80, the Tu-85 was abandoned in favour of the mighty 'Bear'. Itself a fine machine, the nuclear-capable Tu-85's range was bettered only by the B-36.

TUPOLEV

Tu-95 'BEAR A/B/C/G'

● Intercontinental bomber ● Long career ● Unique design



▲ *A familiar sight to many Western pilots during the Cold War period, the huge Tu-95 could be seen and heard for great distances, simulating its deadly mission against NATO forces.*

Having beaten off a stiff challenge from Myasishchev's jet-powered M-4 'Bison', Tupolev's Type 95 was developed into the Tu-95M 'Bear-A' bomber. As the potential of the aircraft was recognized, new variants were quickly developed. Both the 'Bear-B' and 'Bear-G' were rebuilds of the Tu-95M, while a number of new-build 'Bear-Cs' also entered service. All were dedicated missile carriers and a few remain in service.

PHOTO FILE

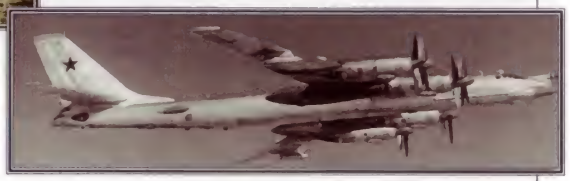
TUPOLEV Tu-95 'BEAR A/B/C/G'

▼ Painted undersurfaces
Some 'Bears' were given black-painted undercarriage nacelles and wing trailing edge surfaces in an attempt to hide exhaust stains.

▲ Soviet Union's big stick
Intercepted by a US Navy F-8 Crusader, this Tu-95 'Bear-A' was the original strategic bomber variant. The lower fuselage and rudder were often painted in anti-flash white in later years.

Might of the motherland ▶
For more than 20 years Tupolev's giant bomber represented the pinnacle of Soviet military power. Able to roam far and wide, it justifiably caused great concern among NATO countries.

◀ Flying Guinea pig
One Tu-95 was used in trials as a mother ship for a high-speed reconnaissance aircraft. The project was cancelled and the 'Bear' later put on display.



Elint role ▶
Among the early variants was the intelligence-gathering Tu-95KM 'Bear-C'. Most of these aircraft were later rebuilt as 'Bear-G' dedicated cruise-missile carriers.

FACTS AND FIGURES

- In 1953 the first Tu-95 crashed during a test flight after an engine fell off. All but three of the crew escaped.
- Most Tu-95s had been scrapped by the 1990s, in accordance with SALT treaties.
- A single Tu-96, high-altitude variant was built, but did not enter service.
- Some design features of the Tu-95 can be traced back to the Tu-4, an exact copy of the B-29 Superfortress.
- Production of the Tu-95 began in 1954 and ended in 1959, with 173 being built.
- Escape for the pilots was by means of a special lift, located near the nose gear.

PROFILE

Tupolev's Cold War Giant

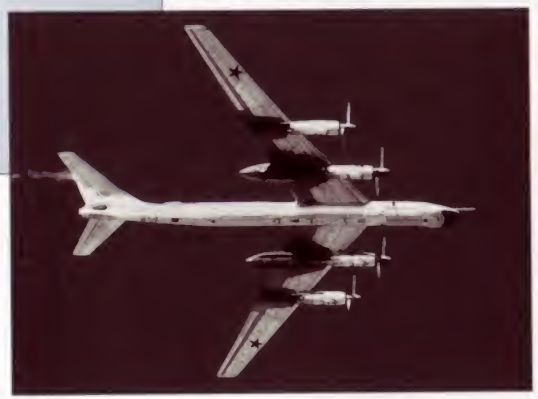
Tupolev was authorized to proceed with its Type 95 on 11 July 1951. The new aircraft proved the concept of the swept-wing turboprop-powered bomber, but it also showed that more development work was necessary to produce an operational machine.

Two prototypes, 95/I and 95/II, were subsequently completed and these were to pave the way for the Tu-95M with increased fuel capacity and revised operational equipment.

Known in the West as the 'Bear-A', the Tu-95M (M for modernized) was a basic free-fall nuclear bomber. Many of these machines were converted to Tu-95K 'Bear-B' standard, with provision for firing the giant AS-3 'Kangaroo' missile.

From 1960, a number of new-build, multi-role Tu-95KM 'Bear-Cs' were joined by several machines modified from earlier airframes, while an early 1970s project designed to produce a cruise-missile carrying aircraft resulted in several 'Bear-As' and 'Bear-Bs' being substantially reconfigured to Tu-95K-22 'Bear-G' standard, with chin-mounted 'Crown Drum' missile guidance radar.

Above: These 'Bears' are carrying huge Kh-20/AS-3 'Kangaroo' missiles during an air show near Moscow.



Below: A swept wing, combined with huge turboprop engines, resulted in outstanding performance.

Tu-95KM 'Bear-C'

Type: Long-range intelligence gathering aircraft and stand-off cruise missile platform

Powerplant: four 11,033-kW (14,795-hp) Kuznetsov NK-12MV turboprop engines

Maximum speed: 860 km/h (534 mph)

Cruising speed: 750 km/h (466 mph)

Combat radius: 6080 km (3,778 miles)

Range: 12,500 km (7,767 miles)

Service ceiling: 11,600 m (38,058 ft)

Weights: empty 81,200 kg (179,015 lb); loaded 182,000 kg (401,241 lb)

Armament: six 23-mm (0.91-in) cannon

Dimensions:

span	50.04 m (164 ft 2 in)
length	46.17 m (151 ft 6 in)
height	12.50 m (41 ft)
wing area	283.70 m² (3,054 sq ft)

Tu-95KM 'Bear-C'

This particular example represents a Tu-95KM 'Bear-C'. All these aircraft were rebuilt from the original bombers and were used both for Elint gathering and as cruise missile platforms.

The standard crew complement in early Tu-95s was two pilots, two navigators, a flight engineer and radio operator/gunner. Most of the crew were housed in the pressurized nose section and could escape via a special emergency lift.

Earlier strategic bombers had insufficient performance, so the Kuznetsov bureau was given the task of designing a suitable engine for the Tu-95. The massive NK-12 turboprop which resulted was, and still is, one of the most powerful in the world.

Extensive tests were conducted in order to come up with an aircraft which was turboprop-powered, but offered jet-like performance. Tupolev's answer was to sweep the wing 35° to achieve the necessary targets. For reduced drag, the main undercarriage was fitted to the inner engine nacelles.

Like the wings and horizontal stabilizers, the tail was also swept back, albeit at a modest angle. Most 'Bear' variants were fitted with twin 23-mm (0.91-in) cannon in a tail turret. Aircraft converted into Tu-95KM 'Bear-C's later had the turret faired over and replaced by an elongated conical section, housing electronic countermeasures (ECM) equipment.

Barely visible in this illustration is the rear dorsal turret, which was a feature of early 'Bear' variants.This was based on a system dating back to the B-29 and was fully retractable. It was deleted on some aircraft.

In order to cope with the immense torque of the NK-12 engines, giant four-bladed contra-rotating propellers were fitted.

Single main wheels were fitted to the 'Bear's' predecessor, the Tu-85. To cope with the increased weight of the Tu-95, tandem units were introduced.

Distinguishing features of the Tu-95KM were the twin Elint blisters located on either side of the rear fuselage. Below them were camera ports, indicating a reconnaissance role for this variant.

ACTION DATA

MAXIMUM SPEED

With its slow-turning turboprops, the 'Bear' was one of the slowest strategic bombers, although this factor resulted in great fuel economy and efficiency in comparison with jet-powered bombers such as the B-52 Stratofortress and M-4 'Bison'.

RANGE

Although the Tu 95 may have been slow, combining the turboprop engines with a swept wing resulted in an incredible range, the aircraft being able to cover huge distances with few problems. Both he B-52 and M-4 could not quite match the endurance of the 'Bear'.

SERVICE CEILING

In addition to its range and fuel economy, the Tu-95 could also operate at greater altitudes than either the Boeing B-52 or M-4. High altitude interceptors and bomber destroyers had to be developed specifically to challenge these bombers.

'Bear' derivatives

■ **TUPOLEV Tu-116:** In the late 1950s, the Soviet Union lacked a suitable VIP transport aircraft for Nikita Khrushchev and other government leaders. An interim solution was found by modifying two Tu-95 bombers with plush interiors.

■ **TUPOLEV Tu-114 'CLEAT':** Design began on the Tu-114 before the Tu-116 took to the air and this aircraft featured an entirely new and larger fuselage, mated to the wings and tail surfaces of the 'Bear'. It entered service with Aeroflot in 1961.

■ **TUPOLEV Tu-126 'MOSS':** A military derivative of the Tu-114, the 'Moss' provided the V-VF (Soviet air force) with a long-range airborne early warning (AEW) aircraft. The type was replaced during the 1980s, by the more capable A-50 'Mainstay'.

TUPOLEV

TU-128 'FIDDLER'

● Heavy interceptor ● Ultra-long range ● World's largest fighter

The Tu-128 was developed in the late 1950s to defend the Soviet Union against the threat of B-52 bombers armed with long-range stand-off missiles. This enormous interceptor was based on an unsuccessful bomber design, the Tu-98 'Backfin', and carried long-range missiles designed specifically for it. The Tu-128's highly specialized role meant that only limited numbers were built, and it has now been replaced by the MiG-31 and Su-27.

▲ *Defending the Soviet Union's borders was a huge task and required large numbers of sensors, thousands of missile sites and highly specialized long-range interceptors such as the Tu-128.*

PHOTO FILE

TUPOLEV Tu-128 'FIDDLER'

▼ Guided missiles
The sole armament of the Tu-128 was the R-4 air-to-air missile, which was unique to the type and was available in both radar-guided (R-4R) or infra-red (R-4T) versions.

▲ Threats from the West
The Tu-128 was developed specifically to intercept airborne threats from America, including the naval A-5 Vigilante and B-70.

◀ Unrivalled range
The long-ranged 'Fiddler' could patrol along interception lines at ranges of between 600 and 965 km (373 and 600 miles) from base.

▼ Improved interceptor
Introduced into service in 1979, the Tu-128M had a more capable RP-5M Smerch-M fire-control radar as well as four new R-4PM and R-4TM missiles.

▲ PVO protector
Tu-128s served with the PVO from 1961 until 1988, and were also used for long-range bomber escort.

FACTS AND FIGURES

- In the West the 'Fiddler' is also often referred to, incorrectly, as the Tu-28; in fact only the factory code is 'Type 28'.
- Development of the Tu-128 began after the failure of the Lavochkin La-250.
- Test pilots for the Tu-128 included would-be cosmonaut G. Beregovi.
- The Tu-128UT trainer version had a third cockpit buried in the bulged, radar-less, part-glazed nosecone.
- Tu-128 backseat weapons operators trained on the specialized Tu-124Sh 'Cookpot'.
- An early Tu-128 was damaged during its attack on an Il-28M target drone.

PROFILE

Facing the Western threat

Probably no more than 200 Tu-128s were built for the Soviet home defence fighter force (PVO) and frontal aviation air regiments (VVS); not many survived in service into the 1990s. The aircraft's huge size enabled it to carry all the equipment needed to intercept bombers before they could penetrate to within their missiles' effective range.

A powerful radar scanner in the nose enabled the Tu-128 to locate intruders at long ranges. Twin afterburning engines enabled it to reach speeds of up to 2085 km/h (1,296 mph) and it could take off with enough fuel for patrols lasting up to six hours.

Just as important were its weapons. The R-4 missile, designated AA-5 'Ash' by NATO, had 60-km (37-mile) range in its active radar-homing (ARH) version and delivered a 65-kg (143-lb) high-explosive warhead. The R-4 missile was also available with an infra-red seeker, and two missiles of each type were usually carried. Although the ARH version weighed 580 kg (1,279 lb) and the IR version 545 kg (1,202 lb), the 'Fiddler' carried all four comfortably under its huge 17.5-m (57-ft 5-in) wingspan.

Above: When the Tu-128 design emerged it was similar in size, shape, power and weight to the failed Tu-98 bomber.

Right: Two separate missile homing systems made the Tu-128 more able to defeat enemy jamming.

Five variants saw service: the Tu-128, the Tu-128UT trainer, the LORAN-equipped Tu-128Ch, the Tu-128A with Smerch-A radar and the final production Tu-128M.

Tu-128M 'Fiddler'

Type: two-seat ultra-long-range interceptor and escort fighter

Powerplant: two 104.9-kN (23,539-lb-thrust) Lyul'ka AL-7F-4 afterburning turbojets

Maximum speed: 2085 km/h (1,296 mph) at 11,000 m (36,089 ft)

Range: 2565 km (1,594 miles) with allowances for combat

Combat radius: 600–965 km (373–600 miles) on patrol

Service ceiling: 20,000 m (65,617 ft)

Weights: empty 25,960 kg (57,232 lb); maximum take-off (Tu-128) 43,000 kg (94,800 lb)

Armament: two R-4PM and two R-4TM air-to-air missiles (AA-5 'Ash')

Dimensions:

span	17.67 m (58 ft)
length	30.49 m (100 ft)
height	7.00 m (23 ft)
wing area	96.94 m² (1,043 sq ft)

TU-128CH 'FIDDLER'

Serving with the Soviet PVO, the Tu-128 was the largest fighter-type aircraft ever built. The last have now been replaced by the MiG-31 'Foxhound' and Su-27 'Flanker' interceptors.

Both crewmembers entered via an 11-rung ladder. The pressurized cockpit had alternate red/white lighting and KT-1 ejection seats, and was protected by a heavy-duty upward-hinged metal canopy with a bullet-proof V-windscreen.

Fuel was carried in eight central fuselage tanks and twin wing tanks. With a total fuel capacity of 14,850 kg (32,739 lb), external tanks and air-to-air refuelling were considered unnecessary.

Four wing pylons carried R-4T (later R-4TM) infra-red and R-4R (later R-4PM) radar-guided air-to-air missiles. Generally, the IR weapons were carried inboard, with the radar-guided weapons outboard. The weapons had to be loaded using a specially built powered trolley because they were so heavy.

The Tu-128 was originally designed to use new VD-19 turbojets, but was eventually powered by the AL-7Fs of the unsuccessful Tu-98 'Backfin' bomber. Later versions introduced improved AL-7F-4 turbojets.

The fuselage and tail were similar in configuration to the older Tupolev Tu-98, but lacked the tail turret gun armament of the bomber. Instead, the tail held an enormous 50 m² (538 sq ft) brake parachute within a thermally insulated container just beneath the lower fuselage.

The large radome contained an RP-5 radar as part of the Smerch fire-control system. The prototype aircraft had a large ventral fairing containing a receiver antenna for target echo-reception.

Avionics included an AP-7P autopilot, an NVU-B1 navigational complex and a Put-4 flight-control system giving semi-automatic level flight guidance, airfield homing, altitude/heading hold, auto-runway approach and auto-return to a pre-programmed position.

As on the Tu-22 and early Tupolev airliners, the main undercarriage retracted backwards into giant wing trailing-edge bullet fairings.

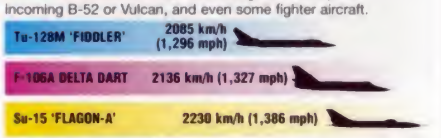
COMBAT DATA

MISSILE RANGE

The Tu-128M had excellent range and was equipped with long-range missiles allowing it to strike from a distance. The F-106A had AIM-4 medium-range missiles, but they were unreliable. The Su-15 also carried infra-red and radar-guided missiles, the AA-3 'Anab'.

MAXIMUM SPEED

Carrying huge quantities of fuel for its engines, a second crewmember and a heavy radar and missiles, the Tu-128M was not an agile performer compared to Russia's smaller MiG-21 and Su-15. However, it was fast enough to intercept an incoming B-52 or Vulcan, and even some fighter aircraft.



COMBAT RADIUS

The Su-15 was an all-out performance machine, with speed and a large radar as the design priorities rather than range. The F-106A was a dedicated air defence aircraft and had medium range and moderate performance. Neither aircraft could match the range of the Tu-128M, which patrolled 900 km (560 miles) from base.

Soviet interceptors

MiG-21 'FISHBED': In January 1963 the first examples of this classic combat aircraft took their place in the front line of Soviet air defence. Early aircraft were known as the 'Fishbed-C'.

MiG-23 'FLOGGER': Initial production models of the MiG-23, with limited capability, entered service late in 1970. By 1976, 2000 of the improved MiG-23M were in service.

MiG-25 'FOXBAT': In February 1962 authorization was granted to begin production of the 'Foxbat' to counter the threat posed by the B-70 and A-12. First deliveries were in 1973.

Su-27 'FLANKER': Now distributed among the states of the former Soviet Union, the 'Flanker' represents the pinnacle of Russian interceptor development.

TUPOLEV

Tu-16 'BADGER'

● Twin-jet nuclear bomber ● Maritime strike ● Reconnaissance

When the Tupolev Tu-16 first appeared, it came as a shock to Western experts. Many had believed that the Soviet Union lacked the skill to build a modern jet bomber, but the 'Badger' proved them wrong. With its two enormous engines the Tu-16 was no beauty queen, but it was easily one of the most capable aircraft in its class, and helped to make the Soviet Union a truly global power.

▲ *Quite apart from its bombing capacity, the Tu-16 is equipped with a 23-mm (0.91-in) cannon in the nose. Aimed by the pilot, it is deadly against small surface craft in the anti-shipping role.*

PHOTO FILE

TUPOLEV Tu-16 'BADGER'

▲ Thirsty for fuel
A Tu-16 'Badger-G' refuels from a Tu-16N 'Badger-A', using a modernized system first tested on the Tu-2 and Tu-4. In-flight refuelling trials were first carried out by the Tu-16Z in 1955.

▲ Flat-nosed killer
In the nose of the 'Badger-C' is a large radar in a massive radome, used to sniff out ships for a missile attack at enormous range.

◀ Ruling the waves
For many years 'Badgers' were the Soviet Union's main naval weapons. They were usually armed with giant missiles such as these 'Kennels', two of which were carried under the wings.

▲ Missile carrier
Egyptian 'Badger-Gs' were used to launch 25 missiles against Israeli targets during the Yom Kippur War of 1973.

Camera ship ▶
To produce a reconnaissance version, a modified 'Badger-A' bomber was equipped with a camera-sensor pallet in the bomb bay.

Mediterranean snooper ▲
Special electronic reconnaissance variants of the 'Badger' flew from Egyptian bases in the 1970s. They were Soviet aircraft, but wore Egyptian markings to confuse the West.

FACTS AND FIGURES

- The Tupolev design bureau's first big bomber was the Tu-4 'Bull', a copy of the B-29 Superfortress.
- Russia's first jet airliner, the Tu-104, was a 'Badger' with a different fuselage.
- Russian Tu-16 pilots underwent seven years of training before their first mission.
- The 'Badger-G' carries AS-5 'Kelt' or AS-6 'Kingfish' long-range nuclear missiles.
- 'Badgers' dropped real atomic bombs during Soviet atmospheric tests.
- The Tu-16's two Mikulin engines delivered as much power as the six J47 engines on the USAF's Boeing B-47.

PROFILE

'Badgers' on patrol

First flown in April 1952, the Tu-16 was seen as a medium bomber complement to the four-engined 'Bison'. Unlike its contemporary, however, the twin-engined 'Badger' proved to be an outstanding design.

The Tu-16 brought the jet age to Moscow's strategic air fleet, and was a joy to fly in spite of the grim purpose of atomic war for which it was designed. Pilots of the 'Badger' held a commanding view and had enormous power and reach at their fingertips.

The Tu-16 possessed the range to make one-way nuclear attacks on the North American heartland. It was never easy on the controls, but in the hands of a good pilot it performed well, sliding easily through the stratosphere, bearing down on its target and ready to strike with some of the earliest nuclear stand-off missiles.

Spyplanes were as important as bombers during the Cold War; both sides played a potentially deadly game of 'cut and thrust', testing the other side's defences. Half a dozen 'Badger' versions flew aerial espionage missions, using a wide variety of radio, radar, optical and electronic sensors. The West's jet fighters often intercepted and stalked them as they probed at the fringes of NATO's airspace on their cloak-and-dagger missions.

Egypt, Indonesia and other nations friendly to the USSR operated Tu-16s as conventional bombers. Missile-carrying, electronic and reconnaissance versions still remain in service.

Tu-16 'Badger-A'

Type: strategic bomber, reconnaissance aircraft and tanker

Powerplant: two 93.17-kN (20,955-lb-thrust) Mikulin AM-3M single-shaft turbojets

Maximum speed: 1000 km/h (621 mph)

Range: 4800 km (2,983 miles) with weapon load

Service ceiling 13,000 m (42,650 ft)

Weights: empty 33,000 to 37,500 kg (72,753 to 82,673 lb); loaded about 68,000 kg (149,914 lb)

Armament: six 23-mm (0.91-in) NR-23 cannons in radar-directed manned tail turret and remotely aimed upper dorsal and rear ventral barbettes; up to 9800 kg (21,605 lb) of nuclear or conventional bombs or missiles

Dimensions:

span	33.50 m (109 ft 11 in)
length	36.50 m (119 ft 9 in)
height	10.80 m (35 ft 5 in)
wing area	164.65 m² (1,772 sq ft)

Tu-16K 'Badger-C'

Despite its age, the Tu-16 still has a useful part to play in today's combat scenarios, having outlasted all its contemporaries. Missile carriers such as this one were targeted against NATO ships, and could have launched a sizeable barrage of nuclear missiles at Western fleets if all-out war had been declared.

The wing of the 'Badger' is too thin to house the main wheels, so they retract into streamlined fairings built into the wing's trailing edge.

Unlike most Western aircraft of the same era, the Tu-16 carries a heavy defensive armament of six 23-mm (0.91-in) cannon in three turrets. The dorsal turret is aimed from a small blister behind the cockpit.

The ventral guns are aimed through the large observation blisters on each side of the rear fuselage.

Carriage of the massive 'Kingfish' missile was usually restricted to one wing pylon, although two could be carried on short-range missions.

The 'Badger' normally operates with a six-man crew with pilot, co-pilot, navigator and flight engineer in the front crew compartment.

The massive radome houses the radar code-named 'Puff Ball' by NATO. With a range in excess of 150 km (93 miles), it is used for ground mapping as well as target search and track.

Known to the Russians as K-26, the 'Kingfish' weighs about 4500 kg (9,921 lb) at launch. It has a range estimated at 200 to 500 km (124 to 311 miles), depending on its launch height.

Tu-16s have a unique refuelling method; the tanker trails a hose from its wingtip, and this is then hooked by the receiver's wing tip.

The rear gunners were housed in their own pressurized compartment, with no connection to the flight deck.

'Kingfish' attack

At the height of the Cold War, one of the main functions of the Soviet navy's 'Badger' force was to threaten the US Navy's Carrier Battle Groups.

HIGH LEVEL: At high level the Tu-16 could launch its missile from 600 km (373 miles).

SUPERSONIC CRUISE: The 'Kingfish' cruises at Mach 3, using inertial guidance with mid-course updates.

LOW LEVEL: At low level, the 'Kingfish' needs to climb to its operating height, restricting range to around 400 km (250 miles).

TERMINAL DIVE: 'Kingfish' can home in on enemy radar or use its own radar to locate the target. Once the target has been found, the missile dives in for the kill.

COMBAT DATA

MAXIMUM SPEED

The first generation of subsonic jet bombers were as fast as the fighters of their time, and were probably more manoeuvrable at typical operating altitudes.

Tu-16 'BADGER-A'
1000 km/h (621 mph)

B-47 STRATOJET
975 km/h (606 mph)

VALIANT
912 km/h (567 mph)

TUPOLEV

TU-22 'BLINDER'

● Supersonic strike ● Missile carrier ● Tail-engined design

The Tupolev Tu-22 'Blinder' is now an obsolete design, but its sleek airframe was highly advanced when it entered service, and a few are still flying. One of the fastest bombers of its time, the 'Blinder' was designed with fighter-like aerodynamics, and could dash through hostile defences to deliver a heavy load of conventional or nuclear weapons. Export 'Blinders' saw action in Africa and in the Iran-Iraq War, on long-range strikes.

▲ *The Tu-22 was designed in an era when supersonic jet bombers were a potent new threat. Combined with nuclear-tipped AS-4 missiles and powerful ECM equipment, the 'Blinder' was a powerful anti-ship strike aircraft facing NATO.*

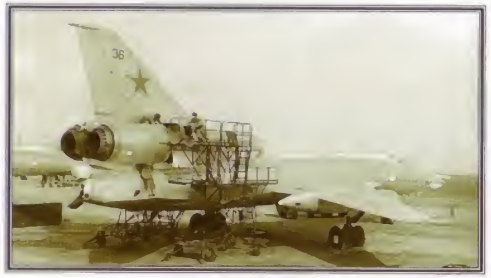
PHOTO FILE

TUPOLEV TU-22 'BLINDER'

▼ Ready for scrap
About 200 Tu-22s remained in service in the early 1990s, but many have been scrapped to comply with the CFE (Conventional Forces in Europe) disarmament treaty.

▲ Blinder trainer
The Tu-22UB is a special conversion training variant with a second cockpit raised aft of the front cockpit. Only a few remain in service.

◀ Fast touchdown
Landing a Tu-22 needed care and a strong brake parachute due to its high touchdown speed.



▲ Engine change
The prototype Tu-22 flew with AM-3 engines, but these were replaced by Koliesov VD-7M turbojets.

▼ Formation leader
This Tu-22 leads a flight of MiG-21s in a display. The 'Blinder' was rarely seen outside the Soviet Union, except when shadowing NATO ships.

FACTS AND FIGURES

- The 'Blinder' first flew in 1959 and was seen publicly at the Tushino aviation display in 1961.
- Iraqi 'Blinders' were used in supersonic toss attacks against Iranian cities.
- The Tu-22 was used by Libya to attack N'Djamena airport in Chad in 1986.
- Some 400 'Blinders' were built in the 1960s, but virtually all of them have now been retired.
- The Ukraine has about 35 'Blinders' flying with operational units.
- Soviet 'Blinders' were used to bomb Mujahideen positions in the Afghan War.

PROFILE

Tupolev's supersonic Striker

An impressive design, the Tu-22 'Blinder' remains an almost unique example of a tail-engined jet bomber. Intended to fly many of the missions of the slower, more vulnerable Tu-16 'Badger', the Tu-22 was designed with an area-ruled fuselage and sharply swept wing to reduce supersonic drag. Although its speed was impressive it suffered from a lack of range, and later versions were fitted with a refuelling probe to remedy this.

A radar-guided cannon turret was installed in the tail.

Other unusual features were the downward-firing ejection seats for the crew, a tailskid to prevent the tail hitting the runway and the large 'Down Beat' missile guidance radar in the 'Blinder B', used in association with the AS-4 'Kitchen' air-to-surface missile.

Soviet 'Blinders' flew as bombers, missile carriers, maritime strike aircraft and as reconnaissance platforms. Russia and the Ukraine operated the type into the 1990s, but the only exports were to Libya and Iraq. Libya used a 'Blinder' in a high-level attack on N'Djamena airport in Chad dropping four bombs, all of which hit the target. Iraqi Tu-22s saw action during the long war with Iran, but most were destroyed by Coalition raids during Operation Desert Storm.

Now retired, the 'Blinder' will be remembered as a symbol of the USSR's Cold War might.

Tu-22s were frequently spotted close to NATO exercises in the Baltic and North Sea. 'Blinder-C' was a dedicated maritime reconnaissance variant equipped with long-range cameras.

The 'Blinder' was designed as a Tu-16 replacement, but the older Tupolev was a more versatile design in many ways.

Tu-22 'Blinder'

Type: supersonic bomber

Powerplant: two 156.9-kN (35,289-lb-thrust) RKBM (Koliesov) VD-7M turbojets with afterburning engines

Maximum speed: 1480 km/h (920 mph) at 12,000 m (39,370 ft)

Combat radius: 3100 km (1,926 miles)

Service ceiling: 18,300 m (60,039 ft)

Weights: basic empty about 40,000 kg (88,185 lb); maximum take-off about 83,900 kg (184,968 lb)

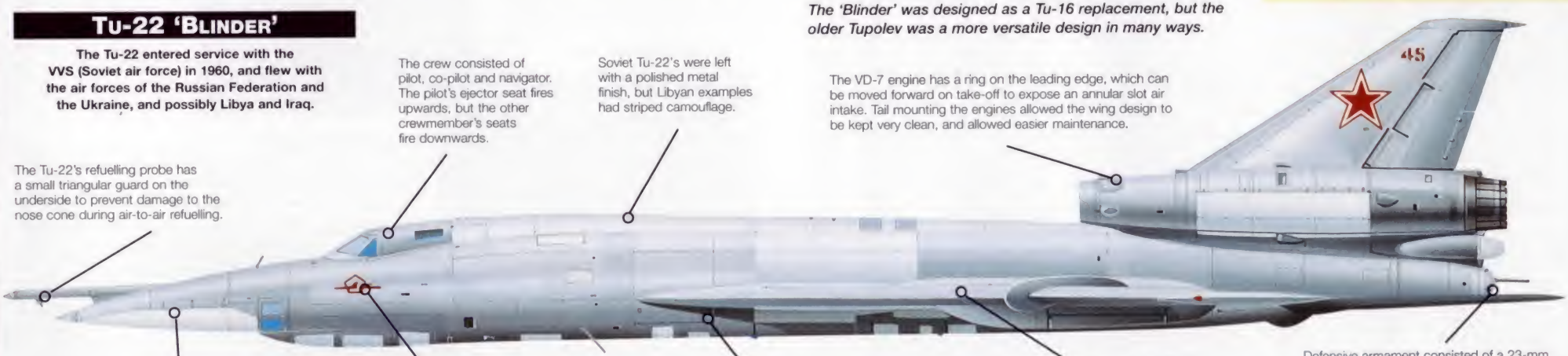
Armament: up to 9070 kg (19,996 lb) of nuclear or conventional bombs or missiles including AS-4 'Kitchen' air-to-surface missiles carried in recessed bays by some variants; one 23-mm (0.91-in) NR-23 cannon in tail barbette

Dimensions:

span	23.75 m (77 ft 11 in)
length	10.67 m (35 ft)
height	10.67 m (35 ft)
wing area	144.00 m² (1,550 sq ft)

TU-22 'BLINDER'

The Tu-22 entered service with the VVS (Soviet air force) in 1960, and flew with the air forces of the Russian Federation and the Ukraine, and possibly Libya and Iraq.



The crew consisted of pilot, co-pilot and navigator. The pilot's ejector seat fires upwards, but the other crewmember's seats fire downwards.

Soviet Tu-22's were left with a polished metal finish, but Libyan examples had striped camouflage.

The VD-7 engine has a ring on the leading edge, which can be moved forward on take-off to expose an annular slot air intake. Tail mounting the engines allowed the wing design to be kept very clean, and allowed easier maintenance.

The Tu-22's refuelling probe has a small triangular guard on the underside to prevent damage to the nose cone during air-to-air refuelling.

'Blinder-B' has a slightly enlarged nose radome to accommodate the large 'Down Beat' radar. Other variants had cameras and electronic warfare equipment installed in the nose.

The small badge under the cockpit is an excellence award to the ground crew for efficiency in maintaining the aircraft in a high state of readiness.

Offensive weapons were accommodated in an internal bomb-bay. The AS-4 missile was carried in the fuselage in a semi-recessed position which replaced the bomb-bay.

Like many transonic Soviet designs, the Tu-22 had large wing fences to reduce induced drag. The highly swept wing gave very light handling at high speed, but landing speeds were very fast, which made a brakechute a vital feature.

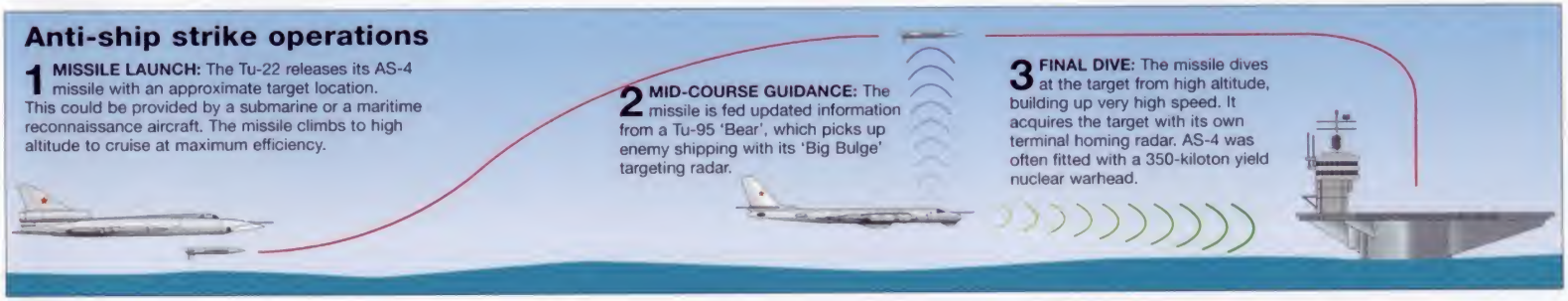
Defensive armament consisted of a 23-mm (0.91-in) cannon with automatic radar tracking from the 'Bee Hind' fire-control radar above it.

Anti-ship strike operations

1 MISSILE LAUNCH: The Tu-22 releases its AS-4 missile with an approximate target location. This could be provided by a submarine or a maritime reconnaissance aircraft. The missile climbs to high altitude to cruise at maximum efficiency.

2 MID-COURSE GUIDANCE: The missile is fed updated information from a Tu-95 'Bear', which picks up enemy shipping with its 'Big Bulge' targeting radar.

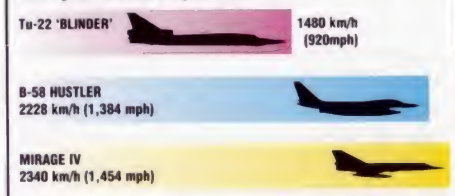
3 FINAL DIVE: The missile dives at the target from high altitude, building up very high speed. It acquires the target with its own terminal homing radar. AS-4 was often fitted with a 350-kiloton yield nuclear warhead.



COMBAT DATA

MAXIMUM SPEED

The Tu-22 had a high dash speed, but even this was surpassed by the B-58 and Mirage IV. The B-58 Hustler could maintain its terrific speed for more than an hour, unlike the short-ranged Tu-22 which guzzled fuel at a high rate.



TUPOLEV

TU-95 'BEAR-D/E'

● Powerful strategic bomber ● Ultra-long-range maritime patrol

One of the most majestic sights in aviation is the Russian 'Bear' bomber, cruising at high altitude with bare metal surfaces gleaming in the sun and vapour streaming back from its huge engines. This incredible giant has served Russia valiantly for more than 50 years. Now almost all 'Bears' except the newest versions are close to retirement, and the big Tupolev bomber is becoming an increasingly rare sight.

▲ *The 'Bear-D' was usually not far from any NATO exercise, and frequently flew down the North Sea coast of Britain testing the reaction times of the RAF's Lightning and Phantom interceptors.*

PHOTO FILE

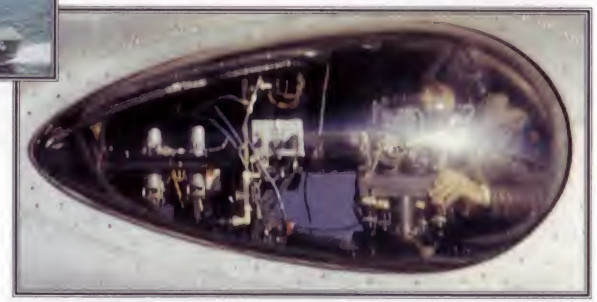
TUPOLEV TU-95 'BEAR-D/E'

▼ A classic bomber
'Bear' sums up the Tu-95's power and strength superbly well: never was a NATO reporting name more aptly chosen.

▲ Pre-jumbo giant
The 'Bear' was used as the basis for the amazing Tupolev Tu-114, the largest and longest-ranged airliner before the Boeing 747. It could carry more than 200 passengers.

◀ Maritime scout
The 'Bear-D' was the most frequently encountered variant, growling over the world's oceans to gather maritime intelligence for the Soviet navy.

▼ East-West relations
Getting in close to a 'Bear' gave NATO pilots and Tupolev crews a chance for some good-natured rivalry – never forgetting that in war the rivalry would have been deadly.



▲ Eye in the sky
NATO navies could expect to pick up a shadowing 'Bear' almost anywhere in the world. In war, the bomber's task would have been to guide Soviet missiles onto US carriers. Other 'Bears' carried nuclear-tipped weaponry such as AS-3 missiles.

FACTS AND FIGURES

- Bombers are designated Tu-95; maritime reconnaissance and anti-submarine warfare variants are designated Tu-142.
- The 'Bear' prototype flew on 12 November 1952.
- The Indian navy operates a small number of naval 'Bears', known as Tu-142Ms.
- The 'Bear'-based Tu-114 airliner was the biggest aircraft in the world when it flew on commercial routes in the early 1960s.
- 'Bears' covered the world from bases in Cuba, Somalia, Angola and Vietnam.
- More than 400 'Bears' have been built in the type's four-decade production run.

PROFILE

In the shadow of the 'Bear'

Now in its sixth decade, the Tupolev Tu-95 'Bear' is one of the most visually stunning aircraft ever built. It is unique in having swept wings and turboprop engines, which use jet power to drive enormous contra-rotating propellers. Tupolev decided this was the only practical way to achieve long range and high-altitude flight for bombing and intelligence-gathering duties, given the limitations of early Soviet jet engines. The huge turboprops made the 'Bear' almost as fast as many jet bombers. The pilots in the big maritime patroller's flight deck are at the controls of one of the biggest and heaviest military planes in history.

A dozen versions of the 'Bear' were built, the 'Bear-D' acting first as a missile-guidance platform, then as a photo-reconnaissance machine when missiles no longer needed target updating. In the reconnaissance role, the 'Bear' was even able to communicate with Soviet satellites. The rarer Tu-95MR 'Bear-E' was a similar update of 'Bear-As', incorporating electronic intelligence-gathering equipment.

Left: The 'Bear' was a truly international performer. The combination of its vast range and the Soviet Union's many bases in client states meant that there was almost no part of the world's oceans that could not be photographed, or attacked.

For decades, 'Bears' flew along the fringes of the West, shadowing NATO's fleets and prying out the secrets and testing the reaction times of opposing air defence systems. As long as they were in the danger zone they were invariably intercepted and escorted by Allied fighters.

The 'Bear-D' remains in limited service with about 15 examples on strength. The sight of a 'Bear', once a common occurrence, is now rare indeed.

NATO fighter pilots have had a lot of practice intercepting 'Bears', and most Western knowledge of the type has come from such regular encounters.

Tu-95RT 'Bear-D'

Type: long-range maritime reconnaissance/ missile guidance aircraft

Powerplant: four 11186-kW Kuznetsov NK-12MV turboprops

Maximum speed: 925 km/h (575 mph) at 9000 m (29,528 ft); cruising speed 710 km/h (441 mph)

Range: 13,500 km (8,389 miles)

Service ceiling: 12,500 m (41,010 lb)

Weights: empty 80,000 kg (176,370 lb); loaded 188,000 kg (414,469 lb)

Armament: two 23-mm (0.91-in) cannon in manned tail turret (other 'Bears' had up to six cannon and a wide variety of bombs, cruise missiles, torpedoes and depth charges)

Dimensions:

span	51.10 m (167 ft 8 in)
length	49.50 m (162 ft 5 in)
height	12.12 m (39 ft 9 in)
wing area	297.00 m² (3,197 sq ft)

TU-95RT 'BEAR-D'

The mighty Tupolev 'Bear' was designed as a conventional bomber. Very early in its career, however, it was given a new role as a long-range target acquisition and maritime reconnaissance aircraft, finding targets for missile guidance.

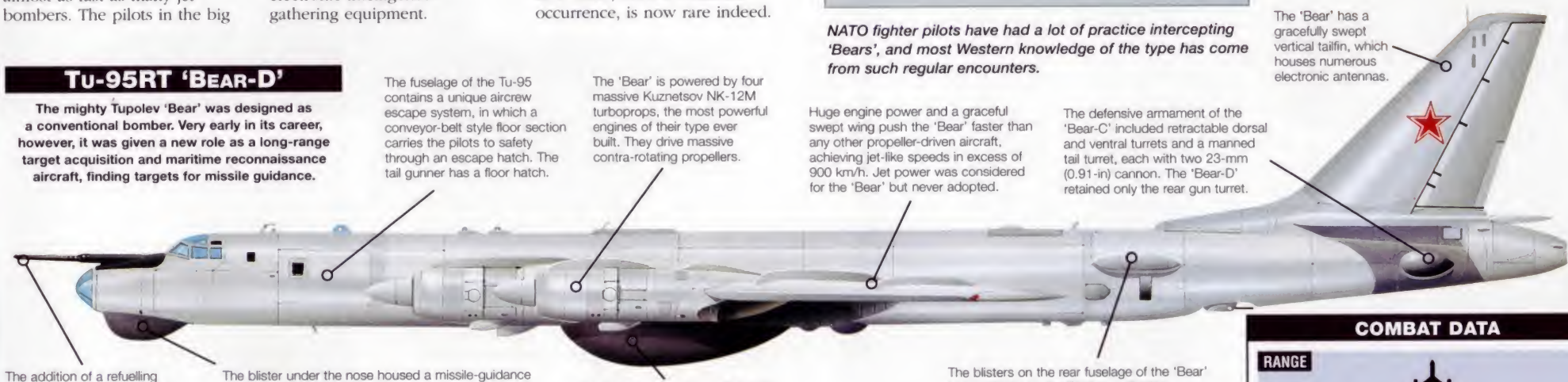
The 'Bear' has a gracefully swept vertical tailfin, which houses numerous electronic antennas.

The fuselage of the Tu-95 contains a unique aircrew escape system, in which a conveyor-belt style floor section carries the pilots to safety through an escape hatch. The tail gunner has a floor hatch.

The 'Bear' is powered by four massive Kuznetsov NK-12M turboprops, the most powerful engines of their type ever built. They drive massive contra-rotating propellers.

Huge engine power and a graceful swept wing push the 'Bear' faster than any other propeller-driven aircraft, achieving jet-like speeds in excess of 900 km/h. Jet power was considered for the 'Bear' but never adopted.

The defensive armament of the 'Bear-C' included retractable dorsal and ventral turrets and a manned tail turret, each with two 23-mm (0.91-in) cannon. The 'Bear-D' retained only the rear gun turret.



The addition of a refuelling probe meant that the 'Bear's' already massive range could be extended indefinitely.

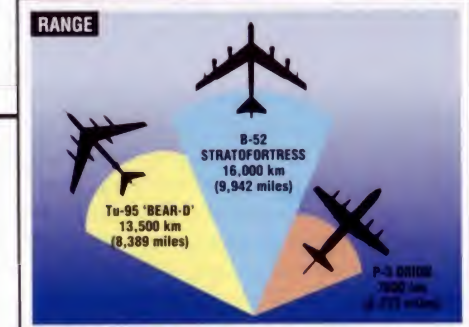
The blister under the nose housed a missile-guidance radar associated with the AS-3 Kangaroo cruise missile. The radar was kept in the RT version, but bomb and missile capability was deleted.

Big Bulge is a very powerful radar, able to detect a large ship at over 250-km (155-mile) range.

The blisters on the rear fuselage of the 'Bear' house electronic intelligence-gathering sensors. A reconnaissance camera port is also visible under the rear of the Elint blister.

COMBAT DATA

RANGE



The keys to effective maritime reconnaissance and strike capability are long range and endurance. The Boeing B-52 is the 'Bear's' only rival in this regard, especially when carrying a heavy weapons load. More conventional maritime patrollers such as the Lockheed P-3 Orion are not in the same league.

Long eyes of the Soviet fleet

THE RED FLEET: Soviet naval doctrine called for the elimination of American carrier battle groups. As a result, Red Fleet warships were very heavily armed with large, long-range missiles with heavy conventional or nuclear warheads.

MID-COURSE GUIDANCE: The largest of the Soviet anti-ship missiles had very long ranges, far beyond any possibility of guidance from their launch platforms. For maximum accuracy they relied on mid-course targeting updates from the 'Bear'.

TARGET LOCATION: In its Cold War maritime role, the 'Bear' was tasked with locating American carrier battle groups either visually or by radar, and transmitting that location to the Soviet fleet.

TUPOLEV

Tu-22M 'BACKFIRE'

● Strategic bomber ● Missile carrier ● Reconnaissance

Fast, long-ranged and hard hitting, the Tu-22M remains one of the most capable bombers in the world. This large swing-wing bomber is tasked primarily with long-range missile strikes against shipping, serving with units of Russian naval aviation (AVMF). Equipped with powerful sensors and large supersonic missiles, the Tu-22M is even more important now that Russia has very few of its Tu-160s remaining in service.

▲ *Together with the Tu-160 'Blackjack', the 'Backfire' makes up Russia's modern long-range bombing fleet. As a replacement for the Tu-22 'Blinder', the 'Backfire' serves in large numbers – 250 in total, with around 150 employed by the naval air arm. It may well drop decoy drones to confuse enemy air defences.*

PHOTO FILE

TUPOLEV Tu-22M 'BACKFIRE'

▲ Ultimate bomber
The Tu-22M-3 is the most advanced and formidable 'Backfire' development, with new radar, engines, intakes and more advanced electronic countermeasures systems.

▲ Anti-shipping strike
This Tu-22M is armed with the AS-4 'Kitchen' anti-ship missile. The 11-m (36-ft) missile has a range of over 400 km (250 miles) and can be nuclear armed.

▲ Maritime patrol and reconnaissance
The Tu-22M-3 'Backfire-C' is used by the Russian navy for long-range destruction of enemy naval fleets. The M-3 can also carry six AS-16 'Kickback' attack missiles internally, plus four more externally. Defence is provided by a 23-mm (0.91-in) tail gun.

▲ Interception
This Tu-22M-2 'Backfire-B' was intercepted over the Baltic by a Swedish Saab Draken fighter.

High-speed attack ▶
The Tu-22M-3 sweeps back its long wings for a rapid bomb run over the enemy fleet's shipping.

FACTS AND FIGURES

- For short landings the Tu-22M can deploy a large brake parachute, stored in the rear fuselage.
- The Tu-22M can carry external rocket packs to decrease take-off distance.
- The 'Backfire' can lift a maximum of 69 FAB-250 conventional bombs.
- Tu-22M-3s were first used operationally on bombing missions in the Soviet war in Afghanistan in October 1988.
- Video cameras are used on the Tu-22M for bomb aiming from high altitude.
- An inflatable LAS-5M dinghy is carried behind the cabin for emergencies.

PROFILE

Soviet swing-wing striker

First known in the West as the Tu-26, the Tu-22M 'Backfire' was developed at the same time as the Su-7IG variable-geometry prototype, and may have benefited from the same research by Soviet aerodynamicists. It is possible that early prototypes (Tu-22M-1) were in fact radically modified Tu-22 'Blinder' airframes, hence the Tu-22M designation. Alternatively, the name may have been adopted simply to confuse Western analysts.

Development began around 1965, and the production Tu-22M-2 'Backfire-B' first flew in 1975. This machine featured a four-man crew, revised undercarriage and two GSh-23 twin-barrel 23-mm (0.91-in) cannon in the tail. Typically this aircraft would be armed with up to three Kh-22 (AS-4 'Kitchen') missiles. After arms limitation treaties the bombers' refuelling probes were removed to reduce their strategic capability.

The later Tu-22M-3 'Backfire-C' introduced a recontoured nose, Kh-15 (AS-16 'Kickback') short-range attack missiles, single GSh-23 cannon, improved wedge intakes and two new NK-25 turbofans. The M-3 first entered service with the Black Sea fleet in 1985, replacing the M-2 in production. An electronic warfare version, the Tu-22M-4, is also rumoured to exist.

For years the Tu-22M was a subject of debate. NATO argued with the Warsaw Pact about its role, and even its real name.

Tu-22M-3 'Backfire'

Type: long-range medium bomber and maritime strike/reconnaissance aircraft

Powerplant: two 245.18-kN (55,144-lb-thrust) Kuznetsov KKBM NK-25 turbofans with afterburning

Maximum speed: (clean and level) 2125 km/h (1,325 mph)

Combat radius: ferry range 12,000 km (7,456 miles); typical combat radius 4000 km (2,485 miles)

Service ceiling: 18,000 m (59,055 lb)

Weights: maximum take-off 130,000 kg (286,600 lb)

Armament: 12,000 kg (26,455 lb) in weapons bay; 12,000 kg on external pylons; three Kh-22 missiles or 10 Kh-15 missiles or bombs, plus one GSh-23 twin barrel 23-mm (0.91-in) cannon in tail

Dimensions:

span	34.30 m (112 ft 6 in)
length	39.60 m (129 ft 11 in)
height	10.80 m (35 ft 5 in)
wing area	170.00 m² (1,830 sq ft)

TU-22M-3 'BACKFIRE-C'

This Tupolev Tu-22M-3 'Backfire-C' is a Russian navy aircraft configured for a long-range anti-shipping mission. The Russian navy has large numbers of 'Backfires', and as newer types begin to enter service with the other air forces, more will be transferred to the AVMF squadrons.

Although no flight refuelling probe is normally carried, one can be bolted on quickly if required for a long-range mission.

Large variable-geometry wings are swept forward for cruise and swept back for a high-speed dash over the target.

The aircraft shown here carries only one of a possible three Kh-22 anti-ship missiles. Alternatively, up to 10 Kh-15s could be carried, or a combination of both weapons.

Two Kuznetsov KKBM NK-25 afterburning turbofans propel the Tu-22M-3 to 2125 km/h (1,320 mph) at an altitude of 11,000 m (36,089 ft). Fuel reserves provide a 12,000-km (7,456-mile) ferry range and a 4000-km (2,485-mile) combat radius.

For defence, a single GSh-23 twin-barrel 23-mm (0.91-in) cannon and associated guidance radar are mounted in the tail.

The Tu-22M-3 introduces not only more powerful turbofans, but also reconfigured high-performance ramp-type intakes similar in shape to those on the Russian MiG-25 'Foxbat'.

The large missile targeting and navigation radar in the nose is code-named 'Down Beat' and is coupled with very advanced electronic systems.

The 'Backfire-C' carries a crew of four, comprising a pilot and co-pilot side-by-side in front and two further crewmembers behind. All four have ejection seats under gull-wing doors.

For conventional missions 12,000 kg (26,455 lb) of bombs can be carried in the weapons bay and another 12,000 kg on underwing racks. The heaviest weapon is the FAB-3000 3000-kg (6,614-lb) bomb.

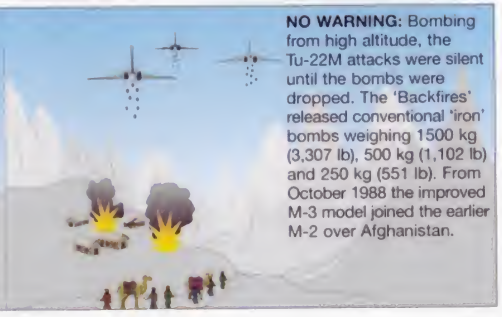
The main undercarriage consists of two heavy-duty six-wheeled units, retracting neatly into the lower fuselage for storage.

'Backfire' over Afghanistan

STRIKE THE PANSHJIR: 'Backfire' squadrons based in the Soviet Union could easily reach distant Afghanistan. They often headed for the Panshjir valley, northeast of Kabul. The Tu-22Ms were tasked with the destruction of towns, villages and the concealed guerrilla bases of Afghan rebels.

ROUTE IN: The 'Backfires' crossed into Afghanistan over high mountain ranges, often using them to help mask their presence.

SAFE FROM ATTACK: Flying high and fitted with decoy flares and chaff launchers, the Tu-22M was safe from the Afghans' Stinger missile system.



NO WARNING: Bombing from high altitude, the Tu-22M attacks were silent until the bombs were dropped. The 'Backfires' released conventional 'iron' bombs weighing 1500 kg (3,307 lb), 500 kg (1,102 lb) and 250 kg (551 lb). From October 1988 the improved M-3 model joined the earlier M-2 over Afghanistan.

COMBAT DATA

MAXIMUM SPEED

Optimized for long-distance missions, the Tu-22M compensates for its slow speed with a very long range and heavy weapons load. The Mirage and FB-111 were designed for shorter missions.

AS-4 'KITCHEN'

Known in the West as the AS-4 'Kitchen', the Kh-22 anti-shipping missile has a range of over 400 km (250 miles) and can carry either a 350-kilotonne nuclear warhead or a 1000-kg (2,204-lb) high-explosive warhead. It makes very steep attacks at extremely high speed.

VICKERS

VALIANT

● First of the V-bombers ● Nuclear and conventional ● Four jet engines

After World War II Britain required a jet-powered, high-flying bomber which was capable of penetrating enemy air defences and delivering a nuclear weapon at long range. In 1947 an official requirement was declared, which led to the procurement of the V-bomber force. Due to the urgent need, the simplest, and therefore the most rapidly available, of the proposals was immediately chosen, and so the Vickers Valiant was born.

▲ *Few problems were encountered on introducing the Valiant into service. The addition of a flight refuelling probe solved an early shortfall in range. The ground and air crew were quickly trained in nuclear procedures.*

PHOTO FILE

VICKERS VALIANT

Night-time preparations ▶
Groundcrew prepare a Valiant B(PR).Mk 1 for a night mission. This variant of the versatile Valiant flew as a strategic photographic-reconnaissance platform.

▼ Valiant prototype
Vickers modified the engine air intakes to the 'spectacle' type, allowing more air to reach the increasingly powerful engines.

▼ Graceful Valiant
An aerodynamically simple but very attractive design allowed the Valiant to enter service earlier than the other two V-bombers.

▼ 'Anti-flash' white
Experts thought that a bright, shiny paint scheme would reflect the radiation of a nuclear blast, protecting the bomber crew from its harmful effects.

On finals ▶
This No. 7 Squadron Valiant, with its large flaps deployed, is ready to land. The squadron relinquished its Valiants in July 1960.

FACTS AND FIGURES

- Rolls-Royce Avon turbojets powered the first prototype; Armstrong Siddeley Sapphires powered the second.
- A grass airfield was used for the Valiant's first flight in 1951.
- Super-Sprite rockets were tested on one Valiant for assisted take-offs.
- Valiants dropped nuclear weapons during tests over Maralinga, Australia, and over Christmas Island.
- Only one B.Mk 2, known as the 'black bomber', was built.
- Valiants dropped conventional bombs in anger during the Suez crisis.

PROFILE

Establishing the nuclear deterrent

Although the Valiant was the least advanced of the V-bombers, it was was nevertheless a very able aircraft which represented a great leap in capability for the RAF.

Having flown for the first time on 18 May 1951, the first prototype was lost in January 1952 when there was an in-flight fire in the left engine bay. The second prototype was rapidly completed, but the production bomber had already been ordered off the drawing board, and the first Valiant squadron, No. 138, received its aircraft in early 1955.

Valiants gave exceptional service in their designed role, and also as strategic reconnaissance platforms and tankers. Unfortunately, a switch to low-level duties caused catastrophic structural failures and the rapid withdrawal of the aircraft in January 1965.

Despite the problems which were caused by these changing roles and faulty alloys in the wing spars, the Valiant was a superb bomber.

Above: Several B.Mk 1 and B(PR).Mk 1 aircraft were converted to tankers and designated B(K).Mk 1 and BPR(K).Mk 1, respectively.

Below: Only one Valiant B.Mk 2 was completed, being optimized for low-level attack. A strengthened wing structure used the space previously occupied by the retracted main undercarriage.

Valiant B.Mk 1

Type: long-range bomber

Powerplant: four 44.7-kN (10,054-lb-thrust) Rolls-Royce Avon RA.28 turbojets

Maximum speed: 912 km/h (576 mph) at 9145 m (30,000 ft)

Initial climb rate: 1219 m/min (4,000 fpm)

Maximum range: 7242 km (4,500 miles) with underwing fuel tanks

Service ceiling: 16,460 m (54,000 ft)

Weights: empty 34,419 kg (75,881 lb); maximum take-off 63,503 kg (140,000 lb)

Armament: one 4536-kg (10,000-lb) nuclear bomb or up to 21 454-kg (1,000-lb) conventional bombs

Dimensions:

span	34.85 m (114 ft 4 in)
length	32.99 m (108 ft 3 in)
height	9.80 m (32 ft 2 in)
wing area	219.43 m² (2,362 sq ft)

VALIANT B.MK 1

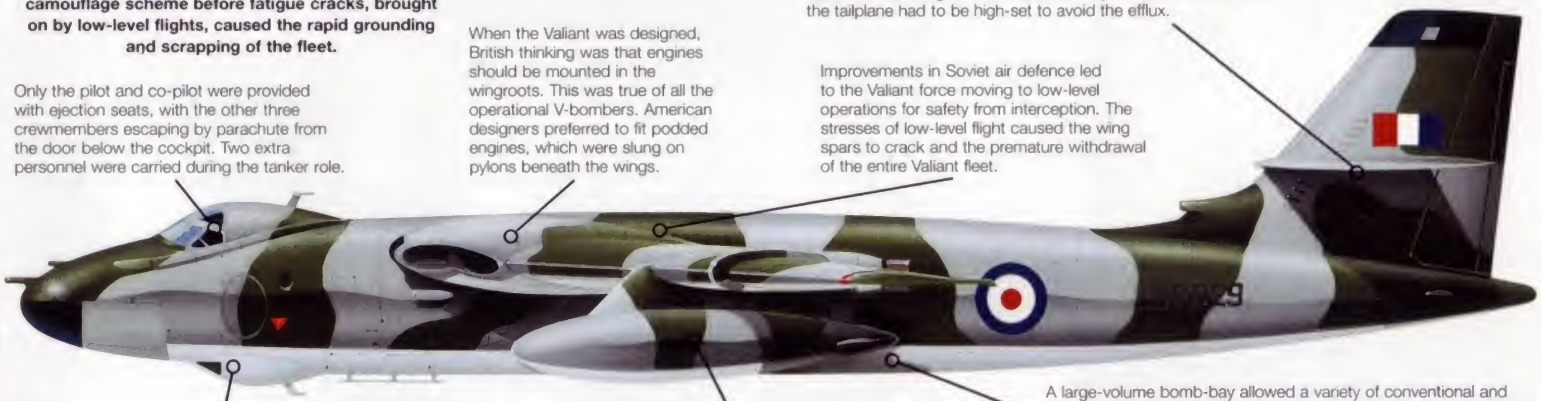
Very few Valiants were finished in this tactical camouflage scheme before fatigue cracks, brought on by low-level flights, caused the rapid grounding and scrapping of the fleet.

Only the pilot and co-pilot were provided with ejection seats, with the other three crewmembers escaping by parachute from the door below the cockpit. Two extra personnel were carried during the tanker role.

When the Valiant was designed, British thinking was that engines should be mounted in the wingroots. This was true of all the operational V-bombers. American designers preferred to fit podded engines, which were slung on pylons beneath the wings.

Mounting the wings at the shoulders of the fuselage produced a large volume of space in the fuselage for the bomb-bay. It also meant that the engines were attached high on the airframe, and the tailplane had to be high-set to avoid the efflux.

Improvements in Soviet air defence led to the Valiant force moving to low-level operations for safety from interception. The stresses of low-level flight caused the wing spars to crack and the premature withdrawal of the entire Valiant fleet.



Principal among the Valiant's bombing aids was the H_2S bombing radar from World War II, but in its improved Mk 9 form.

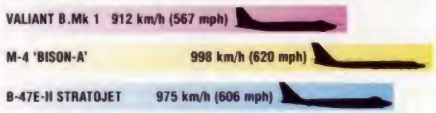
A large fuel tank could be carried beneath each wing, although these were not always fitted.

A large-volume bomb-bay allowed a variety of conventional and nuclear stores, including the American-supplied B43 weapon, to be carried. The bomb doors opened into the fuselage, reducing drag and allowing high speed to be maintained over the target.

COMBAT DATA

MAXIMUM SPEED

Military planners believed that high speed and high altitude were the keys to the successful penetration of enemy airspace. Fighter pilots found it difficult to aim guns at bombers while flying through the buffeting encountered at speeds just below the speed of sound.

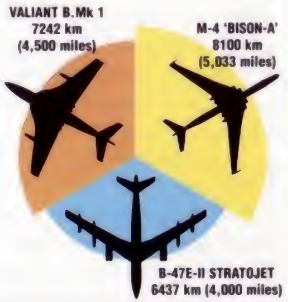


MAXIMUM BOMBLOAD

In the conventional bombing role the Valiant carried a heavier load than these contemporaries. For nuclear strikes the bomb-bay capacity was significant, as nuclear devices were often large. The Valiant was equipped with a huge weapons bay.

RANGE

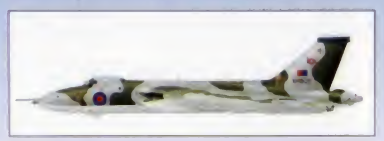
The Myasishchev M-4 'Bison' had long range at the expense of weapons load and never achieved its design promise. Boeing's B-47 Stratojet used six turbojet engines, but paved the way for the B-52. The Valiant did not quite meet the original range requirements, but nonetheless flew long missions.



Britain's V-bomber force

■ **AVRO VULCAN B.Mk 2:** Fitted with a semi-recessed Blue Steel missile and wearing the markings of the illustrious No. 617 'Dambusters' Squadron, this Vulcan has toned-down national markings on its anti-flash paintwork.

■ **AVRO VULCAN B.Mk 2:** Combining tactical green/grey camouflage with white undersides, this aircraft dates from 1964. The Vulcan had a similar bombload to the Valiant, but the Victor could carry 15,876 kg (35,000 lb) of conventional bombs.



■ **HANDLEY PAGE VICTOR B.Mk 1:** Although these aircraft wore colours in keeping with the nuclear strike role, some flew area bombing missions against terrorist camps in the Malayan jungle, armed with conventional weapons.

■ **HANDLEY PAGE VICTOR B.Mk 2R:** These special aircraft were equipped to fire the Avro Blue Steel stand-off missile. A series of small fairings, clustered around the tailcone, accommodated the Blue Steel avionics.

VOUGHT

F4U CORSAIR

● Carrier- and land-based ● MiG-killer ● Korean War

▲ *Marine Corps Corsair operations were flown from US Navy carriers and from shore bases. Together with the USAF's P-51 Mustang, the Corsair bore the brunt of the close support operations in the opening months of the war.*

After their successes with the F4U Corsair in the Pacific during World War II, the US Navy and Marine Corps took Vought's 'Whispering Death' to war again in 1950. This time it was used in the night-fighter and close support roles during the 'police action' in Korea. The United States was so reliant on the Corsair that it was put back into production for the Marines as the AU-1. In this age of the jet's ascendancy, the 'big props' still had a role.

PHOTO FILE

VOUGHT F4U CORSAIR

▲ Dedicated ground attack
Originally known as F4U-6, the AU-1 had a single-stage supercharger to improve low-level performance.

▼ Night-fighter
F4U-5Ns were fitted with a wing-mounted radar and equipped USMC night-fighter units. Twin air intakes fed the supercharger on the R-2800 engine.

▼ Korean winter at Yonpo
The 1st Marine Air Wing F4U-5s flew close support missions from Yonpo in the winter of 1950/51.

▲ F4U-4 with 'Tiny Tim' aboard
This Marine Corps machine carries a 227-kg (500-lb) bomb and a large 'Tiny Tim' unguided rocket. Other typical loads included a 1136-litre (300-US gal) drop-tank and 907 kg (2,000 lb) of bombs.

◀ Running into the target
Seen in a typical low-level close support pose, this F4U-4 carries a standard load of eight 12.7-mm (0.5-in) rockets. The heaviest loads were carried by the AU-1 variant.

FACTS AND FIGURES

- During carrier landings and take-offs, Corsair pilots left the cockpit canopies open for a quick escape in an emergency.
- The famous 'Flying Nightmares', VMF(N)-513, flew F4U-5Ns on night missions.
- Land-based F4Us were often maintained outdoors in primitive conditions.
- During the war, AU-1s flew with all-up weights as high as 8799 kg (19,398 lb), including 2268 kg (5,000 lb) of underwing ordnance and fuel.
- Corsairs were able to loiter over targets, unlike the early short-ranged jets.
- Including Korean War production, 12,571 Corsairs were built.

PROFILE

Gull-wing fighters return to war

Although it was a US Navy carrier-based F4U unit that opened the Korean campaign only eight days after the war began, it was the Marine Corps that flew the bulk of Corsair missions over Korea. Corsairs remained in intensive use for three years, from 1950 until the last day of the war on 27 June 1953.

With a radial engine that was far less vulnerable to small-arms fire, the Corsair was better suited than the USAF's P-51s to ground attack missions. This was to be its main role in Korea – close support of USMC ground forces. Missions were flown from US Navy carriers 'on station' in the Yellow Sea and from shore bases, with units often alternating between the two.

Corsair variants in action over Korea included the F4U-4 (which had first appeared in 1945 and introduced four 20-mm/0.79-in cannon in the -4B), the F4U-5 (including the radar-equipped -5N and 'winterized' -5NL) and the AU-1. First proposed by Vought in 1950 and boasting extra armour, a modified engine and greatly increased weapon load, the Corsair, as the AU-1, was put back into production 10 years after its first flight. By October 1952 111 AU-1s had been built.

Left: Apart from detail improvements, the Corsair's airframe remained largely unchanged since World War II.

Below: An F4U-4 leaves the deck of a US Navy carrier. This major production version was intended to replace F4U-1s from 1945.

F4U-5N Corsair

Type: single-seat night fighter and ground-attack aircraft

Powerplant: one 1715-kW (2,300-hp) Pratt & Whitney R-2800-32W radial engine

Maximum speed: 756 km/h (470 mph) at 8169 m (26,800 ft)

Cruising speed: 365 km/h (227 mph)

Climb rate: 1152 m/min (3,780 fpm)

Service ceiling: 12,619 m (41,400 ft)

Weights: empty 4392 kg (9,683 lb); maximum take-off 6398 kg (14,105 lb)

Armament: four 20-mm (0.79-in) cannon, plus up to 907 kg (2,000 lb) of bombs, rockets and external fuel

Dimensions:

span	12.50 m (41 ft)
length	10.21 m (33 ft 6 in)
height	4.50 m (15 ft 9 in)
wing area	29.17 m² (314 sq ft)

F4U-4B Corsair

BuNo. 97201 was flown by Captain Jesse Folmar, of VMA-312 aboard USS *Sicily*, when he claimed the only Corsair versus MiG kill. After successfully engaging the MiG he was himself shot down by four other MiGs. Folmar was rescued by an SA-16 amphibian.

The F4U-4 was powered by the proven Pratt & Whitney R-2800 Double Wasp 18-cylinder two-row radial engine, rated at 1566 kW (2,100 hp). The F4U-5 and AU-1 used a 1,715-kW (2300-hp) version, although the latter had only a single-stage supercharger as it was intended for low-altitude operations.

The F4U-4 retained some fabric covering of the wing surfaces. This was replaced with an all-metal wing covering in the F4U-5 which reduced drag considerably.

Due to the conditions of the harsh Korean winter, the Dash-5NL variant had wing and tail de-icer boots and de-icer shoes fitted to the propeller. The windscreen had improved thermal de-icing.

Although earlier variants were armed with six 12.7-mm (0.5-in) machine guns, the F4U-4B, -5 and AU-1 were fitted with four 20-mm (0.79-in) cannon.

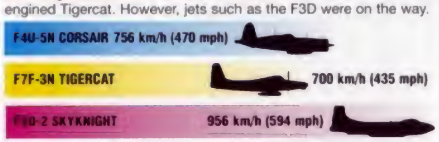
Late Corsair versions had increased load-carrying capability on underwing pylons. The AU-1 had six hardpoints under each wing for up to 2268 kg (5,000 lb) of bombs, rockets and fuel tanks. The normal maximum load was 1815 kg (4,000 lb).

By the 1950s the standard naval colour scheme was an all-over coat of 'midnight blue'.

ACTION DATA

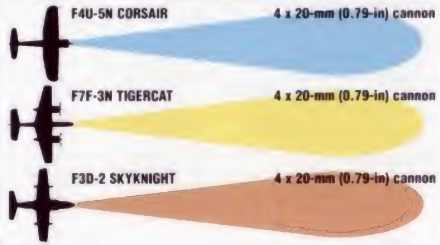
MAXIMUM SPEED

The Dash-5 variant of the Corsair was one of the fastest propeller-driven fighters built – even faster than some versions of the twin-engined Tigercat. However, jets such as the F3D were on the way.



ARMAMENT

The American forces were slow to adopt cannon armament during World War II, but by the late 1940s they had introduced it. Four 20-mm (0.79-in) cannon were common.



KILLS

These kills by Marine pilots flying the three principal US night-fighter types of the war show that propeller-driven types such as the Corsair were still useful, at least against slower targets such as Po-2s.

Corsairs in action over Korea

MIG-KILLER: USMC pilot Jesse Folmar made the only MiG kill by a Corsair in Korea, shooting down a MiG-15 on 10 September 1952.

NIGHT ATTACK: Corsairs in Korea were perhaps at their most deadly in the night-time close-support role. Radar-equipped F4U-5Ns hit Chinese supply trucks.

SLOW SPEED ADVANTAGE: Corsairs were able to shoot down Po-2 and Yak-18 aircraft which were too slow targets for jet fighters.

VOUGHT

F-8 CRUSADER

● Fleet air defence ● Vietnam MiG killer ● Variable-incidence wing

Crusader jocks boasted that their manoeuvrable, cannon-armed jet was hotter than anything in the skies and scoffed when 'experts' said that missiles would make their fighters obsolete. In battle, the pilots were proved correct when their fighter was able to dogfight with Vietnamese MiGs on equal terms. The Crusader was the best-loved fighter in the post-war US Navy and remained in service in France until 2000.

▲ *Just as the US Navy was looking forward to receiving the heavy, complex F-4B, the F-8 was proving that a simple cannon-armed aircraft was ideal for taking on MiG-21s in a dogfight.*

PHOTO FILE

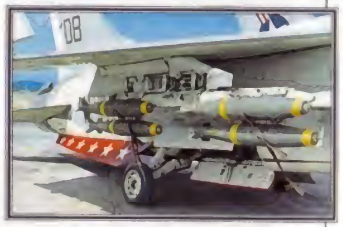
VOUGHT F-8 CRUSADER

▲ **Raised wing**
The Crusader has a variable-incidence wing, which reduces speed when the aircraft lands.

▲ **Folded up**
Wings folded and starboard flap down, an F-8 is prepared for combat. Crusaders shot down 18 MiGs with Sidewinders over Vietnam.

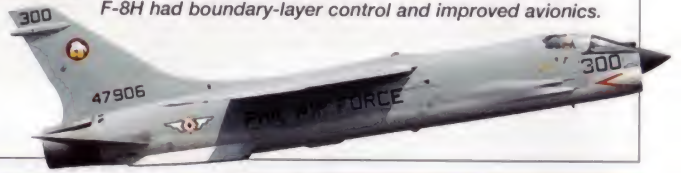
◀ **Two-seater**
One XF8U was converted to a two-seater, with only two cannon but a second set of controls. It first flew in 1962, but did not see active service.

Air to ground ▶
The F-8 was quite capable of bombing as well as air defence, but this capability was seldom used as the US Navy had plenty of A-4 and A-7 bombers.



▼ **Philippine defender**
The Philippine air force was the only other user, but its F-8Hs are now retired. Like the French Crusaders, the F-8H had boundary-layer control and improved avionics.

▲ **French fighters**
Armed with MATRA missiles, the Crusader provided the French navy with its only fighter asset until 2000.



FACTS AND FIGURES

- Test pilot John Konrad flew the XF8U-1 prototype on its maiden flight on 25 March 1955.
- The Philippines air force acquired F-8H Crusaders in the 1980s.
- Vought's XF8U-3 Crusader III was not ordered into production.
- RF-8A photo Crusaders helped to spot new Soviet bases in Cuba during the Missile Crisis of 1962.
- Seventy-one US Navy and Marine Corps squadrons operated F-8 Crusaders.
- Crusaders could also carry the AGM-12 Bullpup missile for ground attack.

PROFILE

MiG killing with the US Navy

One of the first supersonic fighters, Vought's F-8 Crusader (originally F8U) pushed back the boundaries of naval aviation in the 1950s and battled with MiGs in Vietnam a decade later.

Pilots saw the F-8 as the ultimate dogfighter: light, manoeuvrable and packing heavy cannon armament. Unlike many of its contemporaries in Vietnam, notably the F-4 Phantom, the F-8 eschewed missiles, complex avionics and radar in favour of old-fashioned guns and thrust, and pilots loved it.

With its supersonic 'area rule' shape and powerful J57 engine, the Crusader set many speed records and was clearly the world's best carrier-based fighter when it went to war in Vietnam. In action near Hanoi, Crusaders shot down 18 MiG-17s and MiG-21s without a single air-to-air loss. It also took on an extra duty as a carrier-based reconnaissance platform.

With its variable-incidence wing raised for low-speed flight, an F-8 refuels from a Skyraider. French F-8(FN)s had even better low-speed handling than the US versions.

Some Crusaders acquired air-to-ground capability and served the US Marine Corps well during the Tet fighting of 1968. France used this superb jet on its light carriers *Foch* and *Clemenceau*. These last few F-8s flew until 2000 when the Rafale M entered service.

Another innovative feature of the F-8 was the dogtooth, which provided vortexes to improve control at high alpha. The wing also had large leading-edge flaps.

F-8E Crusaders had a small tail-warning radar system, located in the fintip. The top of the fin contained a VHF aerial covered by a fairing.

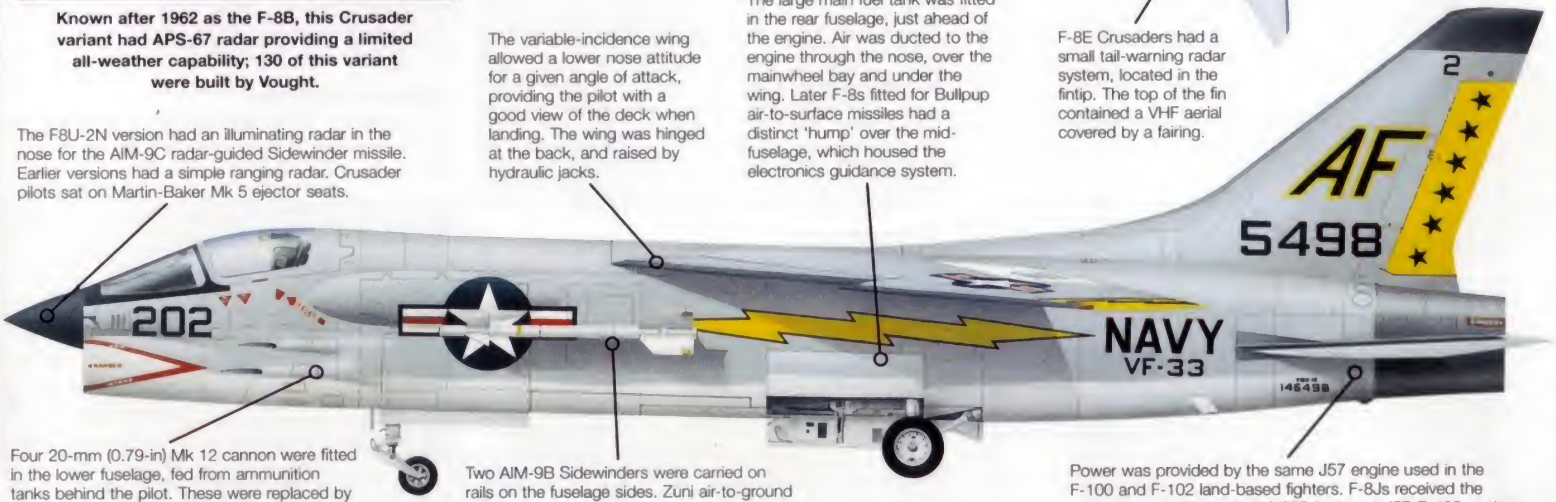
F8U-1E CRUSADER

Known after 1962 as the F-8B, this Crusader variant had APS-67 radar providing a limited all-weather capability; 130 of this variant were built by Vought.

The F8U-2N version had an illuminating radar in the nose for the AIM-9C radar-guided Sidewinder missile. Earlier versions had a simple ranging radar. Crusader pilots sat on Martin-Baker Mk 5 ejector seats.

The variable-incidence wing allowed a lower nose attitude for a given angle of attack, providing the pilot with a good view of the deck when landing. The wing was hinged at the back, and raised by hydraulic jacks.

The large main fuel tank was fitted in the rear fuselage, just ahead of the engine. Air was ducted to the engine through the nose, over the mainwheel bay and under the wing. Later F-8s fitted for Bullpup air-to-surface missiles had a distinct 'hump' over the mid-fuselage, which housed the electronics guidance system.



Four 20-mm (0.79-in) Mk 12 cannon were fitted in the lower fuselage, fed from ammunition tanks behind the pilot. These were replaced by cameras in the reconnaissance RF-8A.

Two AIM-9B Sidewinders were carried on rails on the fuselage sides. Zuni air-to-ground rockets could also be fitted.

Power was provided by the same J57 engine used in the F-100 and F-102 land-based fighters. F-8Js received the more powerful 87.39-kN (19,655-lb-thrust) J57-P-420 engine.

F-8E Crusader

Type: single-seat naval fighter (F-8E)

Powerplant: one 80.07-kN (18,009-lb-thrust) Pratt & Whitney J57-P-20A afterburning turbojet engine

Maximum speed: 1802 km/h (1,120 mph) or Mach 1.7 at 12,192 m (40,000 ft)

Initial rate of climb: 8290 m/min (27,198 fpm)

Range: 1660 km (1,031 miles)

Service ceiling: 17,983 m (59,000 ft)

Weights: empty 9038 kg (19,925 lb); maximum (with external stores) 15,422 kg (34,000 lb)

Armament: four 20-mm (0.79-in) Mk 12 cannon with 144 rounds per gun; up to four AIM-9 Sidewinders AAMs; or 16 113-kg (250-lb) or eight 227-kg (500-lb) bombs; or eight Zuni rockets; or two AGM-12A or AGM-12B Bullpup attack missiles

Dimensions:

span	10.87 m (35 ft 8 in)
length	16.61 m (54 ft 6 in)
height	4.80 m (15 ft 9 in)
wing area	32.52 m² (350 sq ft)

COMBAT DATA

MAXIMUM SPEED

The Crusader was very fast for a naval fighter and could even outrun most land-based types. The very short-range MiG-21s which it faced in Vietnam were slightly faster, but only at high level.

ARMAMENT

Gun armament was seen as obsolete when Crusaders first went to war, a view rapidly ignored by the pilots when the unreliability of early missiles became apparent. Despite this, the Crusader actually scored most of its kills with Sidewinders. The first MiG-21s were gun-armed only, then missile-armed. Like the F-8, it could also carry free-flight rockets for air-to-air use.

RANGE

Designed as a naval fighter from its inception, the F-8 had long range. The MiG-21 was designed as a short-range 'point-defence' interceptor, and was always dogged by a lack of fuel.

Death of a Crusader

■ **HARD TOUCHDOWN:** During a landing on the carrier USS *Franklin D. Roosevelt* in 1961, Lieutenant J. Kryway misjudged his approach and broke the starboard undercarriage of his F-8.

■ **BLOWING UP:** The crash ruptured the engine and fuel tank bays, causing the stricken aircraft to catch fire, then blow up. Lieutenant Kryway was already starting his ejection.

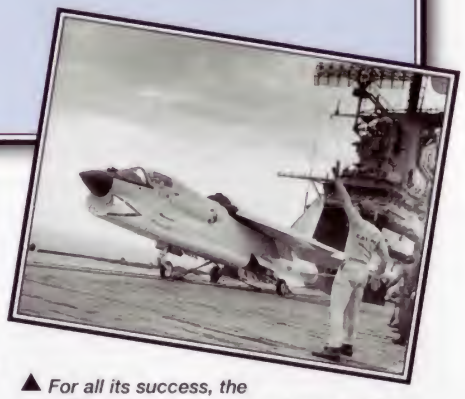
■ **OVER THE SIDE:** With all control lost, the doomed F-8 went over the side of the ship. Here, the canopy is just beginning to lift off the cockpit as part of the ejection sequence.

■ **BLASTED TO SAFETY:** With only milliseconds to spare, Kryway is blasted to safety by his Martin-Baker ejection seat. He was rescued shortly after and survived.

VOUGHT

F-8E(FN) CRUSADER

● Carrier fighter ● Variable-incidence wing ● Superb dogfighter



▲ *For all its success, the Crusader attracted few export orders. The Aéronavale retired its ageing fighters when the first Rafale Ms arrived in 2000.*

One of the most spectacular fighters ever, the Vought F-8 Crusader was chosen by the French Aéronavale in the early 1960s. At that time, the Crusader had already chalked up a superb record with the US Fleet and was soon to wage a near-perfect campaign against North Vietnamese MiGs. Entering French service in 1967, the Crusader became the backbone of France's naval air power aboard the aircraft-carriers *Clemenceau* and *Foch*.

PHOTO FILE

VOUGHT F-8E(FN) CRUSADER

◀ Quad launcher
One of the weaknesses of many fighters in the early 1960s was their lack of weapon load, with only two missiles carried. The F-8E solved the problem by having a new twin missile rail on each side of the fuselage and four cannon.

▼ Turning tight
The F-8E had excellent manoeuvrability, and pilots could out-turn many more modern fighters.

▲ Navy blue
In the early years the F-8E was painted light-grey, but the aircraft later adopted this all-over blue paint scheme to blend in with the sea.

▼ Sidewinder aboard
Unusually for a French aircraft, this F-8E of 14F carries an American-made Sidewinder missile in place of the usual MATRA weapons.

▼ Raised wing
The flash of red paint above the fuselage shows the variable-incidence wing in the raised position.

FACTS AND FIGURES

- France acquired 42 single-seat Crusaders, but it cancelled plans for six two-seat variants.
- A Crusader could fly at about twice the speed of a bullet fired from a pistol.
- The test prototype for the French navy made its first flight in February 1964.
- The F-8E(FN) landed 50 km/h (31 mph) slower than US Crusaders, to permit duty on smaller French aircraft-carriers.
- The first production F-8E(FN) made its initial flight in June 1964.
- Pilots considered the Crusader difficult to fly, but a real pleasure when mastered.

PROFILE

Gunfighter of the Aéronavale

French officers made a dramatic choice when they turned to America for the F-8E(FN) Crusader in 1964; a quantum leap forward when chosen to replace the propeller-driven F4U-5N Corsair and jet Aquilon (developed Sea Venom). With minor changes to the wing and boundary layer systems fitted to the Crusaders in American service, the F-8E(FN) became a stunning performer in French hands. Even today, with the new-generation Rafale flying, many regard the Crusader as one of the finest fighters they ever flew.

Although the Crusader could drop bombs and attack ground targets, the Aéronavale chose to use the F-8E(FN) strictly as an air-to-air fighter. These Crusaders supported Allied operations in the Persian Gulf in 1987, although they were never employed in combat.

The ageing French F-8Es were replaced by the naval Rafale M in 2000.

Left: The F-8E could carry the MATRA R.530 radar-guided missile. In firing trials this weapon had a poor record.

Right: The Aéronavale conducted acceptance trials of the F-8E onboard the American carrier USS Shangri La.

F-8E(FN) Crusader

Type: single-seat carrier-based fighter

Powerplant: one 47.60-kN (10,706-lb-thrust) Pratt & Whitney J57-P-20A turbojet engine

Maximum speed: 1827 km/h (1,135 mph) at 10,975 m (36,007 ft)

Cruising speed: 901 km/h (560 mph)

Range: 2253 km (1,400 miles)

Service ceiling: 17,680 m (58,005 ft)

Weights: empty 9038 kg (19,925 lb); maximum take-off 15,420 kg (33,995 lb)

Armament: four Colt-Browning Mk 12 20-mm (0.79-in) cannon, plus two to four MATRA R.530 or 550 air-to-air missiles or two to four AIM-9 Sidewinder air-to-air missiles

Dimensions:

span	10.87 m (35 ft 8 in)
length	16.61 m (54 ft 6 in)
height	4.80 m (15 ft 9 in)
wing area	32.51 m² (350 sq ft)

F-8E(FN) Crusader

The F-8E is one of very few American types used by the French forces since 1960. The Aéronavale was the last operator of the F-8E, after the US Navy and the Philippines.

The F-8E had a short-range radar for ranging use only. It could not detect aircraft at long range over water or search for targets at low altitude.

For escape from the aircraft, the F-8E was fitted with a Martin-Baker ejection seat. The Crusader had a comfortable cockpit for its era, but rearward visibility was quite poor.

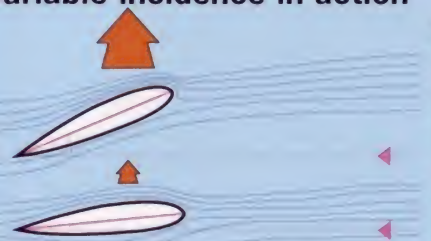
The F-8E was the only jet fighter ever with a variable-incidence wing. The wing used boundary layer control for extra lift during take-off and landing. Bullpup or Zuni rockets could be carried for ground attack, but the Aéronavale did not equip their aircraft with them.

Power was provided by a single J57 engine, as used in the B-52, U-2, B-57 and KC-135. The fixed intake limited the aircraft's speed to less than Mach 2. The F-8 has an all-moving tailplane.

Armament consisted of four Colt 20-mm (0.79-in) cannon, with two MATRA 550 Magic infra-red homing missiles. In the 1960s Sidewinder or R.530 were carried.

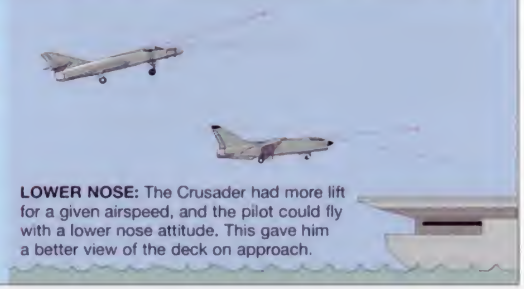
The F-8E, like the RF-8A, had ventral fins fitted.

Variable incidence in action



ANGLE OF ATTACK: Wings generate lift according to the angle of attack – the angle at which the wing meets the oncoming airflow. The lift generated increases with the angle of attack up to about 20° when the wing stalls.

MOVING WING: The Crusader pilot could increase the incidence of the wing (the angle at which it is mounted on the airframe). This was carried out by a large hydraulic jack in the fuselage. For a given incidence the aircraft's attitude could be lowered, providing better cockpit visibility without losing lift.



LOWER NOSE: The Crusader had more lift for a given airspeed, and the pilot could fly with a lower nose attitude. This gave him a better view of the deck on approach.

COMBAT DATA

MAXIMUM SPEED

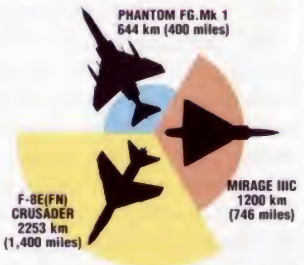
The Crusader was a relatively small fighter with only a single engine, and was not as fast as the Phantom or MiG-21. In a subsonic dogfight, however, it was just as fast as any other fighter, and its legendary agility gave it the edge over many MiG-21s.

CEILING

On the power of one J57, the F-8E could climb to a very respectable altitude. The Phantom had twice the power and was one of the finest interceptors of its day. However, fuel and weapon load often meant that a much lower ceiling was attained in flight.

RANGE

Naval fighters require range, and the F-8E had a good performance. Range is highly dependent on the use of afterburner, which gives a huge increase in thrust but uses fuel up at a massive rate. The Phantom consumed fuel quickly, as it had twin engines.



VOUGHT

A-7 CORSAIR II (USN)

● Vietnam veteran ● Subsonic bomber ● Carrier deployments

There is a saying in aviation, 'if something looks right, it flies right.' Taking into account the stubby appearance of the A-7 Corsair II, one may think the aircraft was therefore a poor performer. In fact the Corsair II proved to be one of the most capable attack aircraft in the US Navy. Replacing the diminutive Douglas A-4 Skyhawk, the Corsair II provided a quantum leap in technology that the US Navy was quick to exploit.

▲ *A typical carrier-deck scene as a US Navy A-7 Corsair is re-armed and prepared for flight. The aircraft achieved an excellent maintenance record whenever operating on deployment.*

PHOTO FILE

VOUGHT A-7 CORSAIR II (USN)

◀ High visibility
Upon entering service, Navy Corsairs proudly displayed colourful squadron markings on their tails and wings.

▼ Leemoore line-up
Early A-7As are positioned prior to inspection by naval ground crews at Leemoore Naval Air Station. One aircraft already has its starboard avionics access panel open.

▼ On the approach
Trailing its tailhook, a Corsair II returns to the carrier from a combat sortie with empty bomb racks.

▲ Compact Corsair
Carrier operations have always been restricted by space. With its folding-wing, a 'Golden Dragons' A-7 Corsair II can taxi while aboard ship.

▲ Carrier attack
A true naval attack aircraft in every way, this Corsair II displays its folding wings and enormous warload. The Corsair II has been used around the world by the US Navy for attack duties and flew its last combat missions during the Gulf War of 1991.

FACTS AND FIGURES

- The A-7 Corsair II was designed as a replacement for the A-4 Skyhawk in the attack role.
- Vought named the Corsair II after the World War II F4U naval fighter.
- The first combat mission for the Corsair II took place in December 1967.
- In all, 395 A-7As, A-7Bs and A-7Es took part in the Vietnam War. They flew with a total of 27 US Navy squadrons.
- The improved A-7E entered service off the Vietnam coast in May 1970.
- Altogether, 54 US Navy A-7s were lost to enemy fire.

PROFILE

Vought's venerable warrior

Often overshadowed aboard the aircraft carrier by the sleek fighters nestled alongside it, Vought's A-7 Corsair II hid its enormous capabilities beneath a short bulky fuselage. Observers seeing the aircraft for the first time often mocked the design, but to naval pilots the A-7 presented them with an ideal attack platform from which to deliver a wide range of bombs and air-to-air missiles.

The A-7A flew its first combat mission in Vietnam in 1967 with VA-147, more commonly known as the 'Argonauts'. Operating aboard USS *Ranger*, the first combat deployment included a cadre of Air Force officers assigned to test the A-7A's combat potential.

A few years later, the US Air Force would request the Vought company to develop a land-based equivalent for it.

Despite its success, the Corsair II encountered problems in service. Pilots found the aircraft had a tendency to suck up catapult steam during launches, which resulted in more than a few accidents.

Above: With its nose leg extended, a Corsair II from USS Coral Sea returns to its home port after a cruise.

Yet the Corsair II achieved the reputation of being one of the most able attack aircraft ever.

Improvements to the avionics allowed the A-7 Corsair II to remain in the front line with the US Navy for more than 20 years, before being retired in 1991.

Below: The striking capability of the naval carrier is depicted in this view of four Corsair IIs over-flying their home carrier.

A-7E Corsair II

Type: single-seat carrier-based attack aircraft

Powerplant: one 66.6-kN (14,979-lb-thrust) Rolls-Royce Allison TF41-A-2 turbofan

Maximum speed: 1123 km/h (698 mph) at sea level

Initial climb rate: 4572 m/min (15,000 fpm)

Combat radius: 1151 km (715 miles)

Service ceiling: 12,800 m (41,995 ft)

Weights: empty 8988 kg (19,815 lb); maximum take-off 19,050 kg (41,998 lb)

Armament: one M61A1 Vulcan six-barrel 20-mm (0.79-in) cannon, plus up to 6804 kg (15,000 lb) of ordnance

Dimensions:

span	11.81 m (38 ft 9 in)
length	14.06 m (46 ft 2 in)
height	4.88 m (16 ft)
wing area	34.83 m² (375 sq ft)

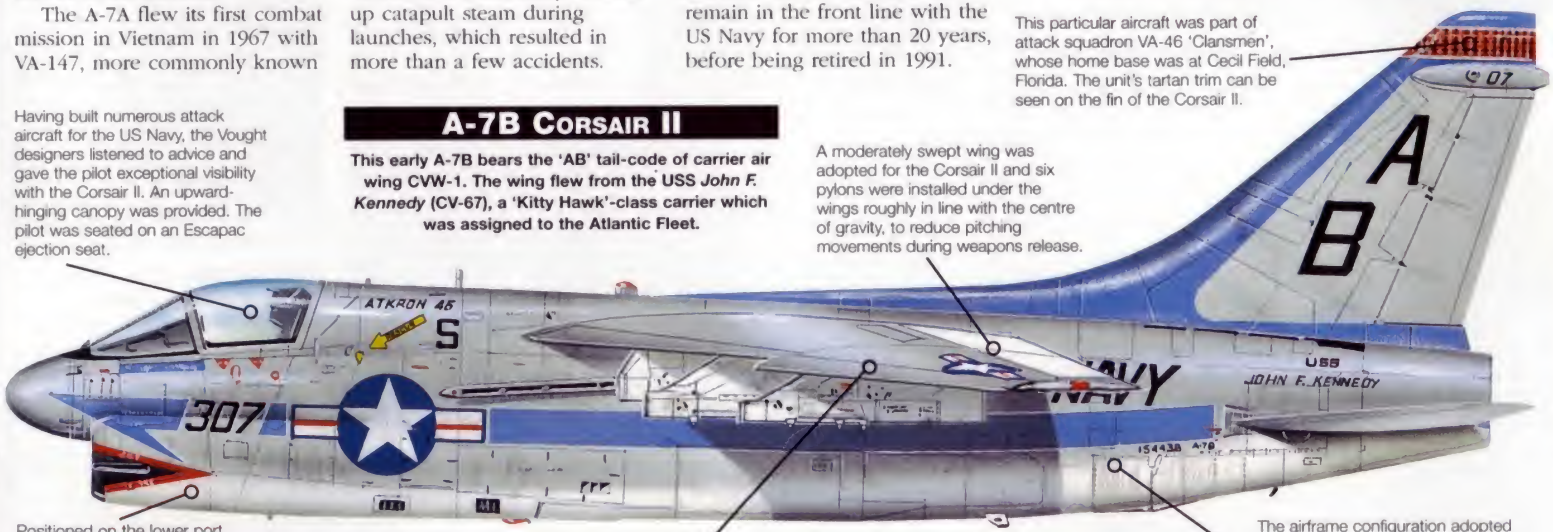
A-7B Corsair II

This early A-7B bears the 'AB' tail-code of carrier air wing CVW-1. The wing flew from the USS *John F. Kennedy* (CV-67), a 'Kitty Hawk'-class carrier which was assigned to the Atlantic Fleet.

Having built numerous attack aircraft for the US Navy, the Vought designers listened to advice and gave the pilot exceptional visibility with the Corsair II. An upward-hinging canopy was provided. The pilot was seated on an Escapac ejection seat.

This particular aircraft was part of attack squadron VA-46 'Clansmen', whose home base was at Cecil Field, Florida. The unit's tartan trim can be seen on the fin of the Corsair II.

A moderately swept wing was adopted for the Corsair II and six pylons were installed under the wings roughly in line with the centre of gravity, to reduce pitching movements during weapons release.



Positioned on the lower port fuselage was a single six-barrelled cannon. This was provided with 500 rounds of ammunition housed behind the cockpit.

To allow stowage beneath aircraft carrier decks, the outer wings of the Corsair could be folded. The aircraft could taxi around the carrier deck like this. The wings would be unfolded prior to launch.

The airframe configuration adopted was unusual, but well suited to undertaking attack missions at high subsonic speeds, both at high and medium altitudes.

US NAVY ATTACK JETS

GRUMMAN A-6 INTRUDER: Providing the United States Navy with heavy attack capability, the A-6 Intruder (pictured below) could undertake solo precision attack missions in all weathers. Constantly upgraded with new avionics, the A-6 Intruder saw heavy combat use in Vietnam. The aircraft was so complex that a dedicated weapons officer accompanied the pilot. One specialized variant – the KA-6D – was a dedicated tanker. This often supported A-7 Corsair IIs on their missions. Despite early problems with its complex radar, the A-6 Intruder proved itself to be a highly capable attack platform.

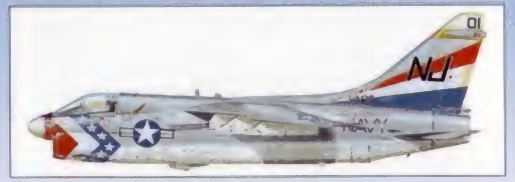
DOUGLAS A-4 SKYHAWK: Often called the 'Scooter' because of the way it flew off carrier decks, the A-4 Skyhawk (pictured below) was so small that folding wings were not required on the aircraft. Having entered service in October 1956, the Skyhawk was found to be limited in capability and, by the early 1960s, the US Navy and Marine Corps were already planning a replacement for the aircraft. Although improvements in attack capability were introduced, the

small size of the design restricted the Skyhawk's use. The limited future potential of the Skyhawk having been established, a request for a more capable attack aircraft was developed. The winning design was ultimately Vought's A-7 Corsair II. Despite its removal from carrier operations, the Skyhawk remained in service with the USMC as a forward-air-control aircraft. For this role, two-seat trainers were specially adapted. The US Navy and USMC also used the Skyhawk extensively in Vietnam.

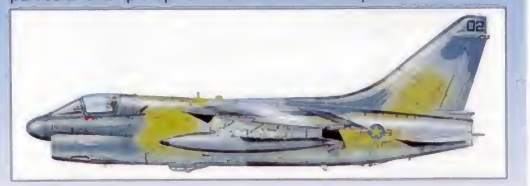
Colourful Corsairs

■ **'BLUE BLAZERS':** An early A-7A, as it appeared in the colours of VA-93. This particular example was based at Atsugi in Japan, but was assigned to the USS *Midway*.

■ **BICENTENNIAL BIRD:** Celebrating America's Independence this Corsair flew in a patriotic red, white and blue colour scheme. The aircraft remained in these colours during 1976.



■ **CAMOUFLAGE CORSAIR:** One of several A-7Es which adopted a low-visibility trial paint scheme for the US Navy. This particular example operated aboard USS *Enterprise*.



VOUGHT

A-7 (USAF)

● Combat-proven ● Single seat ● Subsonic attack aircraft

It is dated today, but for 30 years the snub-nosed A-7 fought in every conflict the United States was involved in and established a dominant position as the world's best single-seat subsonic attack aircraft. The USAF adopted this fine warplane in the mid-1960s after it had been developed by Vought and the US Navy. Pilots called it the 'SLUF' (Short Little Ugly Fella) and loved it with a passion. Over eight years 459 'SLUFs' were delivered to the US Air Force.

▲ *Groundcrew prepare an A-7 for a training mission. The naval origins of the aircraft are given away by its strong main landing gear and long nosewheel strut.*

PHOTO FILE

VOUGHT A-7 (USAF)

▼ A vertical take
The YA-7F, with a new engine and strengthened airframe, offered much higher performance than the standard A-7.

▲ Missile away
A Maverick missile leaves a US Air Force A-7 during armament trials.

A-7 formation ▶
These A-7s are finished in the Vietnam-style camouflage of greens and brown over white.

▼ Flying high
This aircraft carries practice bombs at high altitude. Any operational flying would be done at much lower levels.

▲ Eight pylons
Six underwing and two fuselage pylons give the A-7 the ability to carry a huge load of weapons. The fuselage pylons normally carry Sidewinder missiles for self-defence.

FACTS AND FIGURES

- The A-7 is credited with having an especially roomy and comfortable cockpit area.
- The USAF test-flew Navy A-7s from 27 September 1965.
- The first Air Force A-7 made its initial flight on 26 September 1968.
- Without being catapulted from an aircraft carrier, the A-7 had a typical take-off run of 1707 m (5,600 ft).
- Originally designed for the Navy, the A-7 was known as the Corsair II.
- In Vietnam, a pilot refuelled in flight three times and was aloft for nine hours.

PROFILE

The 'Short Little Ugly Fella'

Once the US Air Force got its version of the A-7 to Vietnam, ground commanders wanted it to throw against the enemy because the A-7 offered a new standard of bombing accuracy. The A-7 also had the 'legs' to rove in enemy territory – no target was too far away or too small to hit with pinpoint precision.

The navigation and weapons delivery system on the A-7 are primitive by today's standards, but in 1967 they were the world's most advanced. Pilots were delighted that they could actually 'pickle' a bomb on a specific building, or on the centre of a bridge, even if the target was in a congested area. The development of laser-guided and other precision weapons was occurring at the same time as the A-7 was appearing on carrier decks, and over time it gained the ability to carry 'smart' bombs.

The USAF used the A-7 in the Sandy mission, escorting rescue helicopters picking up downed airmen in enemy terrain and as a bomber. The A-7 also became a staple with the Air National Guard, which picked up Air Force single-seaters and purchased a handful of two-seat ships.

Left: With US Air Force funding Vought fitted an A-7 with an afterburning engine and modern avionics. This YA-7F did not progress beyond the prototype stage.

Right: USAF A-7s have a 6804-kg (15,000-lb) warload. Here the aircraft carries ten 454-kg (1,000-lb) bombs and two Sidewinder air-to-air missiles.

A-7D

Type: single-seat attack aircraft

Powerplant: one 64.51-kN (14,510-lb-thrust) Allison T41-A-1, US-built version of the Rolls-Royce Spey engine

Maximum speed: 1062 km/h (660 mph)

Ferry range: 5858 km (3,640 miles)

Combat radius: 885 km (550 miles)

Service ceiling: 12,800 m (42,000 ft)

Weights: empty 6861 kg (15,127 lb); maximum take-off 19,011 kg (41,912 lb)

Armament: 20-mm (0.79-in) General Electric M61A1 cannon with 1000 rounds; up to 6804 kg (15,000 lb) of bombs or missiles on six wing and two fuselage pylons

Dimensions:

span	11.81 m (38 ft 9 in)
length	14.07 m (46 ft 2 in)
height	4.90 m (16 ft 1 in)
wing area	34.84 m² (375 sq ft)

A-7D

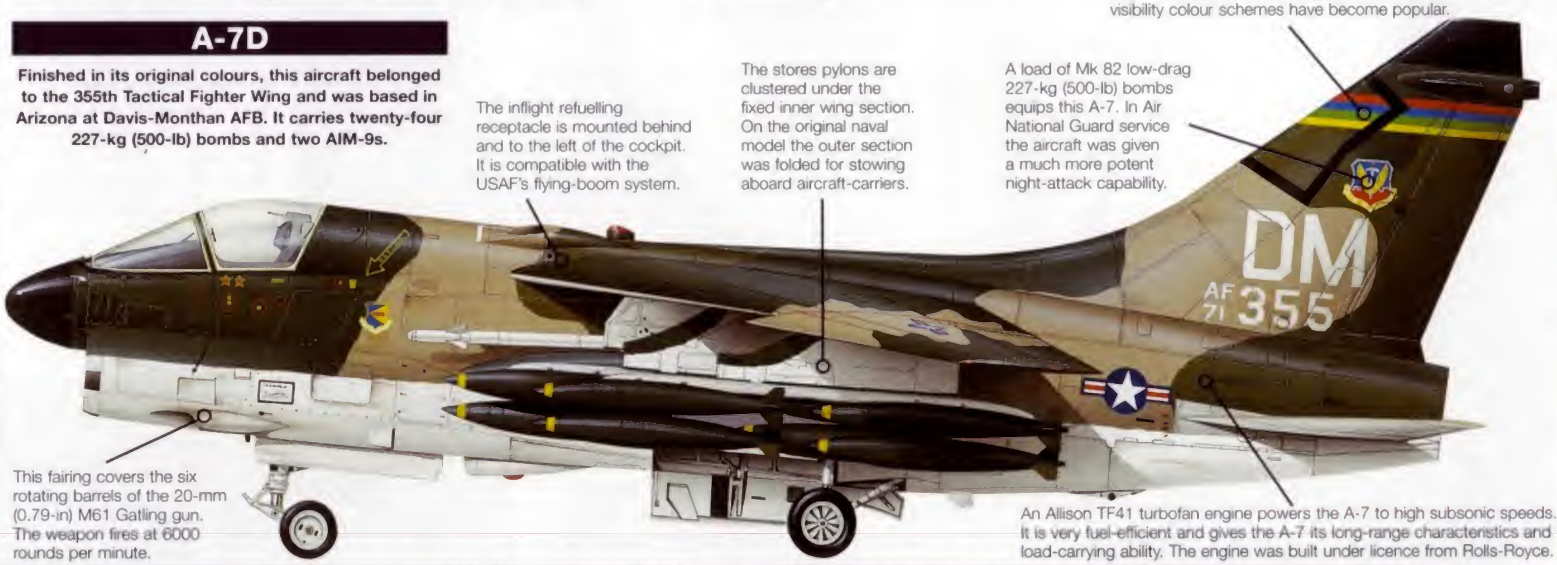
Finished in its original colours, this aircraft belonged to the 355th Tactical Fighter Wing and was based in Arizona at Davis-Monthan AFB. It carries twenty-four 227-kg (500-lb) bombs and two AIM-9s.

The Tactical Air Command shield is carried on the fin and other colourful markings adorn the aircraft. Such markings are increasingly rare since low-visibility colour schemes have become popular.

The inflight refuelling receptacle is mounted behind and to the left of the cockpit. It is compatible with the USAF's flying-boom system.

The stores pylons are clustered under the fixed inner wing section. On the original naval model the outer section was folded for stowing aboard aircraft-carriers.

A load of Mk 82 low-drag 227-kg (500-lb) bombs equips this A-7. In Air National Guard service the aircraft was given a much more potent night-attack capability.



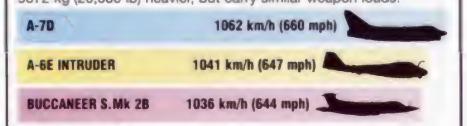
This fairing covers the six rotating barrels of the 20-mm (0.79-in) M61 Gatling gun. The weapon fires at 6000 rounds per minute.

An Allison TF41 turbofan engine powers the A-7 to high subsonic speeds. It is very fuel-efficient and gives the A-7 its long-range characteristics and load-carrying ability. The engine was built under licence from Rolls-Royce.

ACTION DATA

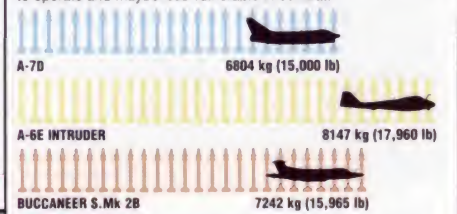
SPEED

These attack aircraft are closely matched in speed. While the A-6 and Buccaneer have twin engines, the A-7 achieves its slight superiority on only one. Both the former aircraft are also around 9072 kg (20,000 lb) heavier, but carry similar weapon loads.



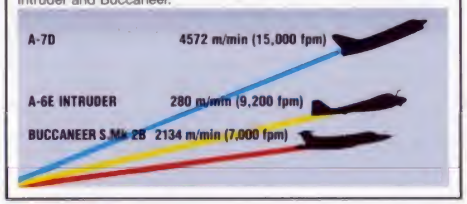
BOMB LOAD

All three aircraft carry a similar bomb load. The A-7, however, is a smaller, lighter and faster aircraft, and is therefore more economical to operate and maybe less vulnerable in combat.



CLIMB RATE

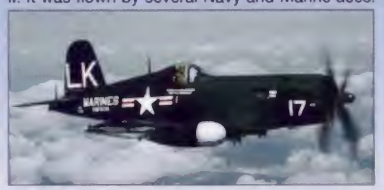
Attack aircraft, which spend much of their time at low level, are often required to make rapid climbs in the course of an attack or during evasive action. Again, the lighter A-7 outperforms the Intruder and Buccaneer.



The Vought dynasty

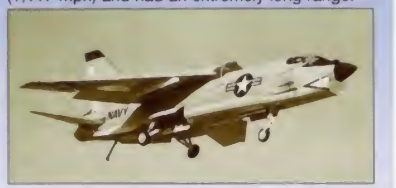
VOUGHT OS2U KINGFISHER: Designed as a scout/observation aircraft, the OS2U also served in the anti-submarine and SAR roles.

VOUGHT F4U CORSAIR: Many experts regard the F4U as the finest fighter of World War II. It was flown by several Navy and Marine aces.



VOUGHT F7U CUTLASS: The F7U first flew in 1948 and was hated by pilots. It later introduced the Sparrow AAM into service.

VOUGHT F-8 CRUSADER: One of the best naval fighters ever, the F-8 could reach 1798 km/h (1,117 mph) and had an extremely long range.



YAKOVLEV

YAK-28 'BREWER'/'FIREBAR'

● Late 1950s design ● Bomber and interceptor ● Long service

Code-named 'Brewer-A' by NATO, the original Yak-28 was a twin-engine supersonic tactical bomber developed from the earlier trouble-plagued Yak-26. The Yak-28 made its public debut at the 1961 Aviation Day flypast. A two-seat interceptor version called 'Firebar' and reconnaissance and electronic counter-measures versions of 'Brewer' followed. Few, if any, are left; some may still be in service with trials and training units.

▲ *'Firebar' first flew in 1960 as a two-seat, low- to medium-level interceptor derivative of 'Brewer'. The nose was redesigned to hold a radar set, the former bomb-bay was fitted with fuel tanks and air-to-air missiles were carried.*

PHOTO FILE

YAKOVLEV YAK-28 'BREWER'/'FIREBAR'

▼ Bicycle landing gear
With a tandem fuselage-mounted main undercarriage, as shown here, wingtip outrigger wheels were needed to support the wings.

Conversion trainer ▶
'Maestro' was the NATO code name given to the Yak-28U unarmed conversion trainer variant that had its second cockpit forward of the main canopy.

▲ Unofficial service
Somewhat strangely, the 'Firebar' did not officially enter service with the Soviet air defence force (PVO); most units received the Sukhoi Su-15 'Flagon'. However, it is known that about 200 Yak-28s served with Arctic-based regiments as late as 1980.

▲ Practice alert
This TASS photograph dated 1979 shows a Yak-28U conversion trainer and crew during a practice alert. Note the 'Brewer' bombers parked in the background.

▼ Northern latitudes
A Yak-28P, with the early-style shorter, fatter radome, during winter weather in northern Russia. Yak-28PMs had a longer radome with a more capable radar set.

FACTS AND FIGURES

- Early versions of the 'Brewer' had a bombing radar fitted; later versions used ground stations for guidance to a target.
- The Yak-28 prototype (the Yak-129) flew for the first time on 5 March 1958.
- 'Brewers' carried either an NR-23 23-mm cannon or the two-barrel GSh-23Ya.
- Radar-equipped 'Brewer-As' had to be raised off the ground to provide access to the bomb-bay for loading.
- Reconnaissance 'Brewer-Ds' carried cameras, radar and infrared detectors.
- The Yak-28-64 fighter was a failed redesign to compete with the Su-15.

PROFILE

'Brewer' of 1960s Soviet vintage

Powered by big turbojets carried in large underwing pods, the original Yak-28 had a glazed nose for the navigator/bombardier and was flown by a single pilot. It carried a 2995-kg (6,600-lb) bombload, and had a 23-mm (0.91-in) cannon in the right side of the forward fuselage.

The configuration enabled it to be adapted for various other roles. 'Brewer-B' and 'Brewer-C' were improved attack aircraft with additional equipment, while 'Brewer-D' was a reconnaissance version with cameras and other equipment such as infrared sensors and radar carried in the bomb-bay.

In 1970, the 'Brewer-E' became the first Soviet electronic countermeasures (ECM) escort aircraft to be deployed. Carrying an ECM pack in the bomb-bay, along with many additional antennas and fairings, it could use chaff launchers or anti-radar missiles to suppress defences.

The Yak-28P 'Firebar', which entered service in the early 1960s, was a two-seat interceptor with a radome replacing the glazed nose of the earlier versions. It carried no guns, and the bomb-bay was used to house additional fuel tanks. There was also a trainer version, the Yak-28U 'Maestro'.

Above: Distinguished by its glazed nose, the 'Brewer' was the first member of the Yak-28 family to enter service. It could carry a hefty bombload and was fitted with a cannon for self-defence and ground strafing. Two fuel tanks (not fitted to these aircraft) could be attached to the outer wings to increase fuel capacity.

Above: The last examples of the Yak-28 family in use are Yak-28PP 'Brewer-E' electronic warfare (EW) aircraft. These were deployed by Russia until at least 1994, after the Ukraine absorbed all examples of the Sukhoi Su-24MP, its intended replacement.

Yak-28PM 'Firebar'

Type: two-seat all-weather interceptor

Powerplant: two 60.02-kN (13,500-lb-thrust) Tumanskii R-11-AF2-300 afterburning turbojets

Maximum speed: 2105 km/h (1,308 mph) at 10,668 m (35,000 ft)

Initial climb rate: 8498 m/min (27,880 fpm)

Combat radius: 925 km (575 miles)

Service ceiling: 15,996 m (52,480 ft)

Range: 2575 km (1,600 miles)

Weights: empty 7734 kg (17,050 lb); loaded 15,867 kg (34,980 lb)

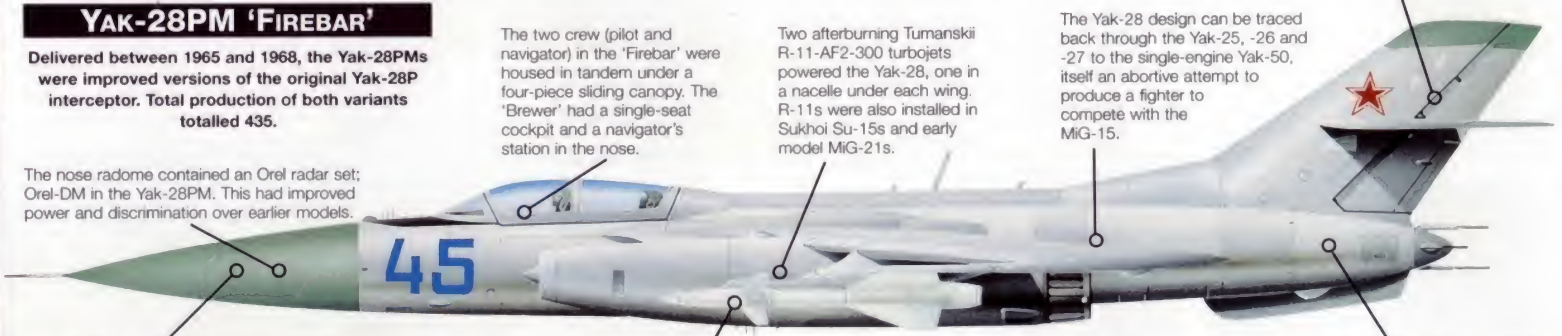
Armament: Two R-8 ('Anab') infra-red and two R-3 ('Atoll') infra-red/semi-active radar-homing air-to-air missiles

Dimensions:

span	11.68 m (38 ft 4 in)
length	21.46 m (70 ft 5 in)
height	3.94 m (12 ft 11 in)
wing area	35.21 m² (379 sq ft)

YAK-28PM 'FIREBAR'

Delivered between 1965 and 1968, the Yak-28PMs were improved versions of the original Yak-28P interceptor. Total production of both variants totalled 435.



The high-set tail was used to provide an undisturbed air flow over the tailplane, away from the disturbed air lower down.

The two crew (pilot and navigator) in the 'Firebar' were housed in tandem under a four-piece sliding canopy. The 'Brewer' had a single-seat cockpit and a navigator's station in the nose.

Two afterburning Tumanskii R-11-AF2-300 turbojets powered the Yak-28, one in a nacelle under each wing. R-11s were also installed in Sukhoi Su-15s and early model MiG-21s.

The Yak-28 design can be traced back through the Yak-25, -26 and -27 to the single-engine Yak-50, itself an abortive attempt to produce a fighter to compete with the MiG-15.

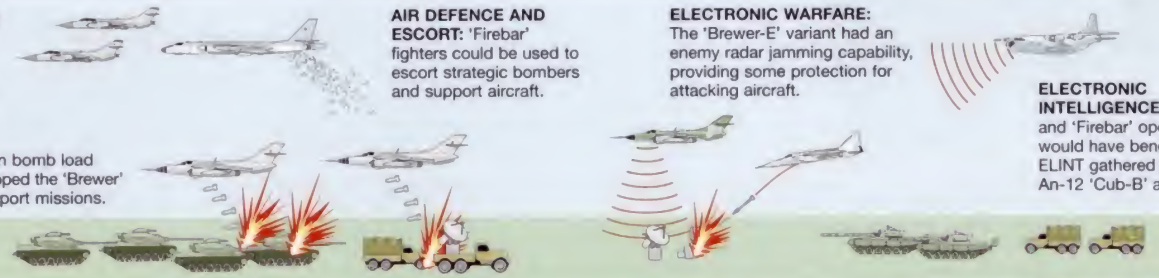
The nose radome contained an Orel radar set; Orel-DM in the Yak-28PM. This had improved power and discrimination over earlier models.

The 'Brewer' bombers had a glazed nose for a navigator/bombardier station. This had successively lighter framing on later variants.

Yak-28Ps carried two R-8 infrared air-to-air missiles (NATO code name 'Anab'); the Yak-28PM added two smaller R-3 ('Atoll') infra-red or semi-active radar-homing missiles.

Similar to Soviet air defence aircraft, 'Firebars' carried minimal markings (a red star and two-digit aircraft code) and wore an unpainted metal finish.

Yak-28s in action



MULTI-ROLE AIRCRAFT: The Yak-28 family comprised different versions that could perform a variety of tasks over a battlefield.

TACTICAL BOMBING: Its three-ton bomb load and a 23-mm (0.91-in) cannon equipped the 'Brewer' bomber versions well for close support missions.

AIR DEFENCE AND ESCORT: 'Firebar' fighters could be used to escort strategic bombers and support aircraft.

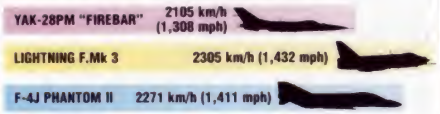
ELECTRONIC WARFARE: The 'Brewer-E' variant had an enemy radar jamming capability, providing some protection for attacking aircraft.

ELECTRONIC INTELLIGENCE: 'Brewer' and 'Firebar' operations would have benefited from ELINT gathered by circling An-12 'Cub-B' aircraft.

ACTION DATA

SPEED

Compared with other interceptors of the mid-1960s, the 'Firebar' had a slightly slower top speed at just under Mach 2. The RAF's Lightning was one of the fastest aircraft of the day.



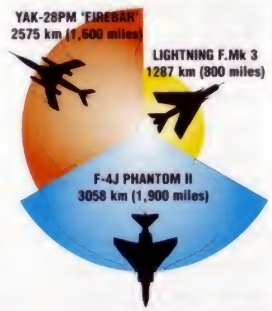
WEAPONS

The F-4 was the US Navy's most modern interceptor of the mid-1960s and had an impressive missile load. The Lightning was relatively lightly equipped, with half as many air-to-air missiles as the 'Firebar'.

YAK-28PM "FIREBAR" 4 x air-to-air missiles | LIGHTNING F.Mk 3 2 x air-to-air missiles | F-4J PHANTOM II 8 x air-to-air missiles

RANGE

Range was never a strong point of the Lightning, unlike the F-4. The Yak-28 also had good range, especially when the limitations of what was a dated design were considered. A handicap was the Yak's inability to refuel in the air, something that the Phantom was equipped to do; early versions of the Lightning were not.



YAKOVLEV

YAK-38 'FORGER'

● Vertical take-off ● Fleet air defence ● Maritime strike

Since 1976, the Yak-38 'Forger' has been Moscow's equivalent of the famous Harrier, but uses three powerplants instead of the Harrier's one for vectored-thrust performance. The vertical take-off jet was designed to spring from the decks of 'Kiev'-class carriers to defend the Russian fleet from Western patrol aircraft and remained in service on the carrier *Gorshkov* until it was sold to India in 1996.

▲ *The Yak-38 gave the Soviet navy experience with high-performance jets at sea, and was a useful stepping stone towards the fixed-wing naval fighters now coming into service with the Russian navy.*

PHOTO FILE

YAKOVLEV YAK-38 'FORGER'

◀ Conversion trainer
The 'Forger-B' is the two-seat trainer variant of the Yak-38. This was a much-needed aircraft as the standard Yak-38 was always a very tricky aircraft to learn to fly. The trainer aircraft lacks underwing pylons, radar or infra-red systems, and is therefore not combat-capable.

◀ 'Freestyle'
The Yak-141 'Freestyle' is the follow-on to the Yak-38, with advanced avionics and increased speed and range. It has not been produced in quantity, and needs a foreign buyer.

▲ On deck
The 'Forger' was not an impressive aircraft by itself, but the overall 'Kiev'-class package was capable and a real threat.

▲ Hover practice
This Yak-38 is hovering, with the lift-engine intake doors opened just behind the cockpit, and jet blast churning the sea.

Pacific fleet ▶
The Yak-38 could be seen all over the world as Soviet sea power expanded. The carrier Novorossiysk, *based in Vladivostok, flew its 'Forgers' all over the Pacific.*

FACTS AND FIGURES

- The Yak-36 'Freehand' of 1967 was the test ship for the better-looking 'Forger'.
- The Yak-38 first carried out sea trials on board the *Kiev* in the Black Sea.
- About 90 'Forgers' were built, but at least 37 have been lost in accidents (with 32 pilots ejecting safely).
- Each aircraft carrier had 12 single-seaters and a pair of two-seat trainers.
- Of four 'Kiev'-class carriers, only one remains in service with Yak-38s.
- The advanced Yakovlev Yak-141 'Freestyle', a supersonic replacement for the 'Forger', has not entered service.

PROFILE

Soviet naval 'jump-jet' fighter

The Yak-38 'Forger' stirred excitement in the West when first seen aboard the *Kiev* in the Mediterranean. Using a main turbojet with twin rotating nozzles plus tandem lift jets behind its cockpit, the 'Forger' performed well in its specialized domain as a V/STOL (Vertical/Short Take-off and Landing) naval fighter.

The Yak-38 was never designed to be in the class of conventional naval fighters; it was aimed at warding off NATO maritime patrol and strike aircraft such as the P-3 Orion and BAe Nimrod. Its radar has only a very limited range, and it carried only the short-range infra-red 'Atoll' missile and cannon. It had limited strike capability, with armament including the unguided UV-32 rocket pod and the short-range AS-7 'Kerry' tactical missile. Neither was suited to attacking a well-defended warship.

The 'Forger' was tested, not very successfully, in Afghanistan. Its main value to the Soviet navy was to give experience in operating jets at sea.

The Yak-36 cannot carry a major warload and is no match for land-based fighters, but it is more than capable of destroying enemy bombers and anti-submarine aircraft.

The cockpit has a head-up display, but is otherwise very simple and quite cluttered compared to modern fighter aircraft.

Fences were later fitted to the upper fuselage above the intakes to improve the airflow.

Four pylons under the fixed portions of the wings can carry up to 2000 kg (4,409 lb) of stores, including bombs, missiles and cannon pods.

The short-span wing folds for shipboard stowage, with a hinge between the flap and ailerons. A 600-litre (159-US gal) fuel tank can be fitted under each wing.

The traditional Yak-38 paint scheme was a naval blue, but this has been changed to a sea grey on the 'Forgers' remaining in service.

YAK-38 'FORGER-A'

The Yak-38 served aboard the 'Kiev'-class aircraft carriers *Kiev*, *Minsk*, *Novorossiysk* and *Baku* (now renamed *Admiral Gorshkov*). This Yak-38 carries the badge of the Red Banner Northern Fleet.

The air intake at the base of the fin directs cooling air into the aircraft's rear electronics bay.

The Yak-38 is unique in having an automatic ejection system, which is used in the dangerous transition phase when taking off or landing.

Twin Koliesov RD-36 lift engines are mounted behind the cockpit. They are not used during wingborne flight.

The Yak-38 radar is a simple model, with a surface search mode and capable of giving range data for infra-red missiles.

Auxiliary blow-in doors were added to the intake walls, to improve engine air flow while in the hover.

The Yak-38 uses a Harrier-like system of autostabilizers with reaction control jets in the wing tips, nose and tail.

The main Soyuz R-27 thrust engine exhausts through twin vectoring nozzles under the tail.

Yak-38 'Forger-A'

Type: single-seat VTOL fighter

Powerplant: one 66.68-kN (14,997-lb-thrust) MNPK 'Soyuz' (Tumanskii) R-27V-300 turbojet; two 31.87-kN (7,168-lb-thrust) RKBM (Koliesov) RD-36-35FVR lift jets

Maximum speed: 1009 km/h (627 mph) in 'clean' condition at 11,000 m (36,089 ft)

Combat radius: 370 km (230 miles) with maximum warload

Service ceiling: 12,000 m (39,370 ft)

Weights: empty 7485 kg (16,502 lb); loaded 13,000 kg (28,660 lb)

Armament: up to 2000 kg (4,409 lb) of underwing stores or four AA-8 'Aphid' air-to-air missiles

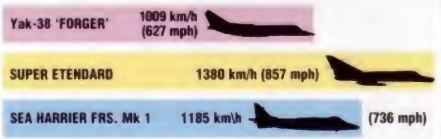
Dimensions:

span	7.32 m (24 ft)
length	15.50 m (50 ft 10 in)
height	4.37 m (14 ft 4 in)
wing area	18.50 m² (199 sq ft)

COMBAT DATA

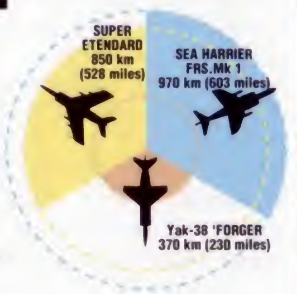
MAXIMUM SPEED

When it first appeared, Western experts assumed that the Yak-38 was capable of travelling faster than sound, but it has since been discovered that the Russian jet is subsonic, and somewhat slower than Britain's Sea Harrier.



COMBAT RADIUS

The penalty for carrying extra weight in the shape of lift engines, which also take up valuable space in the fuselage, is a noticeable deficiency in range. The 'Forger' could not match earlier versions of the Harrier, and, while the British jet's capability has been greatly enhanced, the Yak's range has remained limited.



WEAPONS LOAD

The primary task of the 'Forger' was to destroy Western maritime and anti-submarine warfare aircraft, and although it has been given some air-to-surface capability it cannot strike as hard as land-based fighters. But, although limited, the Yak can match the French Etendard, although it is much less capable than the latest Sea Harrier.

Soviet carrier evolution

■ **HELICOPTER CARRIER:** The 'Moskva' class appeared in the early 1960s. It was a cross between a carrier and a cruiser, and could operate only helicopters.

■ **'FORGER' CARRIER:** Carriers of the 40,000-tonne (45,000-ton) 'Kiev' class had a through-deck, which enabled them to operate with a dozen Yak-38s as well as anti-submarine helicopters.

■ **SUPERCARRIER:** The last gasp of Soviet naval expansion was the supercarrier *Kuznetsov*, which was designed to operate with advanced fighters such as the Su-33 'Flanker'. It has proved far too expensive, however, for a financially challenged Russia to contemplate putting into service.

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